Science Education

The Science Magazine for All Science Teachers

Formerly General Science Quarterly

... CONTENTS ...

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K KNOTT

IDEALS OF SCIENCE

The ideals of science are:

1. To understand nature, that the boundaries of human knowledge may be extended and man may live in an ever-widening perspective.
2. To apply this knowledge to the service of man, that his life may be fuller of opportunity; and
3. To use the method of science in training man, so that he may be able to solve his problems and not be their victim.—*Coulter.*

The ideal of science is one of intellectual development, of a state of mind that is always open to conviction when presented with new evidence.—*Curtis.*

The scientific attitude of mind consists in an honest endeavor to receive the truth whatever its nature and source, in a determination to secure all facts essential to the question at issue.—*Lane.*

Science is concerned with how the universe works; you will adjust your philosophy to a universe that is, instead of one that is not.—*Wiggam.*

By the warp and woof of experiment, the man of science weaves a pattern from the threads of evidence, and presents the result to the world for anyone to use or improve.—*Gregory.*

For discipline, as well as for guidance, science is of chiefest value. In all its effects, learning the meanings of things is better than learning the meanings of words.—*Spencer.*

Accuracy is the foundation of everything else.—*Huxley.*

Science is the effort to find out what to do with the universe, and what to do in the universe.—*Wiggam.*

SCIENCE EDUCATION

Devoted to the Teaching of Science in Elementary Schools, Junior and Senior High Schools, Colleges and Teacher Training Institutions

(Formerly GENERAL SCIENCE QUARTERLY)

Vol. XIII MAY, 1929 No. 4

Science Education

Editorial by W. G. Whitman

Thirteen years ago *General Science Quarterly* was founded. Its mission was to promote the teaching of general science, which was then struggling for existence. Since that time some of its former opponents have become enthusiastic promoters, and others allow that it is not as bad as they expected. The need of a journal to promote general science alone no longer exists. General science has proved its worth, and is, perhaps, more secure in its position in our schools than some of the older sciences.

There are still teaching problems for general science, but they are no more serious than are the problems for science in the elementary grades—nature study—or for biology, chemistry, or physics in the senior high school. There are also very serious teacher training problems for the preparation of properly trained science teachers. The organization of chemistry clubs, of physics clubs, and of biology clubs has helped teachers to concentrate in their own narrow fields, but these have not contributed to a broad view of the whole field of science. Many science educators have come to the conclusion that in addition to our many special science teachers' organizations there is urgent need of some body of teachers who are interested in looking at science education from such a distance that they see not just chemistry, not just physics, not just elementary science or nature study, but rather, that they see the integration and correlation of all of them, and more, that they see the child gradually grow in scientific attitudes and acquire in graded steps significant science experiences.

The idea of graded courses of study from kindergarten to the junior college has so captured the minds of science directors and other leaders in science education that well-directed attacks upon the problem are already under way in many different states. The first products of these first attempts are eagerly awaited by a vast army of science teachers. The pressing need in science education today is to attack the problems of science education in a scientific manner. No one has a copyrighted method for doing this. The field is free for your best thought, your careful trial of a plan and your conclusions. When you or your committee has made progress, the facts should be laid before the teachers at large for testing. Worthwhile comments will come back to you and repay you for your trouble.

All publications in the field of science education, whether specializing in one field or another, can be of much help in promoting this great work; but it is important that there be at least one journal on science education whose only purpose is the promotion of science teaching in all our schools. Such a journal has been started — you are now reading from its first number. Its name is SCIENCE EDUCATION.

At present it is under the editorial management of the following committee, representing the National Association for Research in Science Teaching:

Charles J. Pieper, School of Education, New York University, Chairman

Earl R. Glenn, New Jersey College of Education, Montclair, N. J.

Walter G. Whitman, State Normal School, Salem, Massachusetts

The National Association for Research in Science Teaching

W. L. Eikenberry, *President*

For a number of years it has been clear that real progress in science teaching must rest upon the same foundation as progress in science itself — that is, upon facts developed by fundamental research. There has also been correspondingly a growth of interest in the research related to the problems of science teaching. This is shown by the growing attention to education which is manifest in the activities of such organizations as the American Association for the Advancement of Science and the American Chemical Society, the increasing number of persons who are making education in science their major interest, and the publication of research papers of high standard. The development of research in this field has suffered from three handicaps. There has been no national organization which represented the interests of investigators in the field of science teaching, no meeting of national scope where papers could be read with the assurance of meeting both appreciation and critical evaluation, and no appropriate journal for the publication of such researches. The National Association for Research in Science Teaching was organized to meet these needs. It resulted from a meeting held at Cambridge, Massachusetts, a little more than a year ago.

It was the feeling of the members of the Association that the first year must be a period in which the fundamental characteristics of the institution were growing out of the needs of the situation as they became obvious. In order to allow free opportunity for such internal development, no new members were invited to join, no constitution was adopted, and no publicity was sought. The first program meeting was held at Cleveland during the recent session of the Department of Superintendence, with a very large proportion of members present. In line with the policy of gradual growth, but one session for the reading of research papers was provided, but enough papers were offered to have filled a program of two sessions. Although the meeting was not announced upon the official program, the attendance was much larger than expected. The Secretary's report of the meeting will be found in another place in this issue.

During the past year it became clear that the organization would have to face the problem of providing an avenue of publication in the very near future. The president therefore took upon himself the responsibility of appointing a Committee on Publication, to which was assigned the task of investigating the possibilities that were in sight and reporting to the Cleveland meeting. The result of their very careful work is shown in their report and in the official organ of the association, SCIENCE EDUCATION, in which this statement appears.

Since the Association is now before the public both through its meetings and also through its journal, a statement to the public is in place. To those who are not members of the Association we desire to express the desire of the organization to cooperate with every existing agency looking toward the advancement and improvement of instruction in science in all grades of schools. Everyone is welcome and invited to the program meetings of the Association. Particularly are we anxious to secure attendance of teachers and supervisors of science, and school administrative officers. These meetings will ordinarily be held at the time and place of the meetings of the Department of Superintendence. The journal of the Association will be open for the publication of research by both members and non-members, within the limits which the size of the magazine allows.

The membership of the Association is not at present large but all members are in the true sense active members. New members will be secured by invitation and election by the society. It is not the intention to add to the membership list very rapidly during the formative period.

To the present members of the Association the chairman wishes to suggest that there are three major activities which ought receive our attention during the year. The first, of course, is the promotion of research. We expect to hold two program sessions for the presentation of research papers at our next meeting. The second activity should be the promotion of our journal. The Committee on Publication, now continued in charge of SCIENCE EDUCATION, has suggested in a letter to all members what should be done to promote the publication. Let us give them the support they so richly deserve. And thirdly, it is believed that the time has now come to give the organization a more definite form by preparing a consti-

tution for consideration at the next business meeting. A committee will shortly be appointed for that purpose. In the meantime, send any suggestions for the constitution to the writer and they will be put in the hands of the committee.

The president wishes on the part of the officers and executive committee to thank the members of the Association for the interest, cooperation, and support which the members have generously given during the past year. He desires also to express the thanks of the Association to Professor Whitman for his enthusiasm and generosity in putting *General Science Quarterly*, now SCIENCE EDUCATION, at the service of the Association.

(The Secretary's reports are printed on page 276.)

Equipment for Teaching Physics in Northeast Missouri High Schools

RALPH K. WATKINS, University of Missouri

Why should science teachers in general be concerned with the equipment available for teaching physics in Northeast Missouri high schools or, for that matter, in the equipment of any other limited group of high schools? We are not concerned with a mere enumeration of science equipment, even in that of our own state of Missouri. The question of available equipment becomes pertinent only as it throws light upon what the teacher is able to do with the equipment at hand. Professor C. F. Hodge, formerly of Clark University, told a story of a visit to the biological laboratories of one of our middle western universities. There he found a graduate student counting feathers on a pigeon. Upon being asked his purpose the student replied that he was carrying on a piece of investigation that had never been done before. Professor Hodge immediately asked if his next investigation involved counting the hairs on a dog, adding that this had not yet been done.

In this investigation we have not been interested in counting feathers nor enumerating hairs for the sake of something new to do. As a matter of fact, surveys of equipment have been made by students of science teaching in schools. This study was made in an attempt to throw some light upon the current issue of lecture demonstration as against individual laboratory instruction in high school science teaching.

Is this still a live issue? The Bureau of Education bulletin, 1928, No. 22, *Bibliography of Research Studies in Education,* 1926-27, has just come to hand. In this are listed forty-five studies having to do with science teaching. Seven of these deal either with comparative values of demonstration and laboratory teaching or the relative merits of some type of laboratory instruction.

Early in January of last year Mr. John Harty, Professor of Physics in the Northeast Missouri State Teachers College, came to the present speaker with these questions: "Under actual conditions as they now exist in public schools, can teachers of physics do any satisfactory individual laboratory work with their pupils? If laboratory work is possible at all under present conditions, how much and what can be done?" This study is an attempt at an answer. Mr. Harty did the work and your speaker did the advising and talking. Apparently the latter part of this co-operative arrangement still holds.

The scheme of investigation was as follows. A check list of apparatus was made, following the listings of a standard apparatus catalog. A space was provided at the end of the list for adding apparatus not included. Checking columns were provided to show the quantity of each type of apparatus available; the condition of the apparatus under the headings, good, fair, junk; duplicate use by other science courses under the headings, chemistry, agriculture, biology and general science. Teachers were instructed to enumerate the quantity of each kind of apparatus available for use. The condition was to be checked in the columns under condition, as good, fair or junk. If apparatus was used in other courses this use was to be indicated by checks in the appropriate columns. Mr. Harty visited all schools which he could reach and checked through the list with teachers. The remainder were mailed to the teachers concerned.

The following directions are quoted from the heading of the check list:

"If a piece of apparatus is used in one or more sciences other than physics please place a check in the proper column. For example, if an air pump is used in agriculture and general science as well as in physics, place a check opposite this item in columns headed Agr. and GS. In column Q place the quantity or number of each item. Place a check in the column, good, fair or junk which describes the condition of the piece of apparatus. By junk is meant an item that is no longer valuable for the purpose for which it was intended but may be of some value for other purposes."

In addition to the check list of apparatus and furniture one supplementary data sheet was used. This sheet asked for the following information:

1. Is the laboratory supplied with running water? City gas? Gasoline gas? D. C. current? A. C. current? Compressed air?
2. Is lecture table supplied with running water? City gas? Gasoline gas from school plant? D. C. current? A. C. current? Compressed air?
3. How many hours per week is the physics laboratory used for physics? For other sciences?
4. Is the physics lecture room separate from the laboratory? If so, how many hours each week is the lecture room used for physics? For other classes?
5. How many pupils are now enrolled in physics? Chemistry? Agriculture? Biology? General Science?
6. How much money has been spent during the last twelve months for physics apparatus?

The study was limited to first class high schools in the Northeast Missouri State Teachers College district. There are about one hundred first class high schools in this district. Returns were secured from forty-two of these schools. Of these, the data from three were incomplete, usable in some tables and not in others.

The schools are practically all village or small town high schools. There are no cities in this district. The larger towns from which replies were received are Hannibal, Columbia, Kirksville, Mexico and St. Charles. Hannibal has a population of some 20,000; Columbia 15,000; Kirksville and St. Charles about 8,000 and Mexico 6,000.

Most of the high schools are four year high schools. Three have distinctly separate three year senior high schools. High school enrollments range from a senior high school of 483 pupils to a four year high school of 30 pupils. The number of teachers employed ranges from 30 to 3. Eighteen of the high schools have an enrollment of less than 100. Four have an enrollment of 400 or more.

Several interesting asides grow out of this background. These suggest interesting questions concerning the places in which the physics teaching of the country is being done. The eighteen high schools having less than one hundred pupils have a total registration of 1165. These same schools have 208 pupils enrolled in physics. The four largest schools, each having 400 or more pupils, total a registration of 1771 and

yet have only 178 pupils enrolled in physics. One school of 400 pupils had but five taking physics. Compared with this a school of 78 pupils had 47 of them enrolled in physics. Another school of 77 had 30 pupils in physics.

Most of the smaller schools have classes in agriculture and general science in addition to physics. Two of the four larger schools have classes in chemistry. Seven other schools offer chemistry and five offer biology. It is interesting to note that very few small town and village high schools in this section are teaching biology.

Tabulations of data for the schools studied have been made as follows: (1) the replacement value of the physics apparatus; (2) the estimated present value of physics apparatus; (3) the replacement value of laboratory and demonstration furniture; (4) the amount spent by each school for physics apparatus and furniture in the last twelve months; (5) the general equipment of the school for laboratory and demonstration work, such as running water, gas and electricity; (6) the actual experiments and demonstrations which each school is equipped to perform. In addition to these tabulations, the replacement value of the apparatus per pupil enrolled in physics classes was computed and summarized. The data summarized is presented in Tables I to VI at the end of this discussion.

The material for these tables, with the exception of that in Tables IV and V, was derived rather than direct. The replacement value of the physics apparatus and furniture was estimated by making a standard list of satisfactory moderate priced apparatus, following exactly the check list used in the study. Prices were taken from a standard apparatus catalog of a house which sells most of the supplies in this territory. The replacement value of each piece of apparatus checked by a school was determined by reference to this standard list. This procedure has the advantages of simplicity for the teachers who contributed to the study and that of measuring the equipment value of every school on the same scale. No teacher was asked to make an estimate of the value of his own apparatus. All of the evaluation was done by Mr. Harty.

The present value of the apparatus was derived in the same way. Apparatus indicated as in good condition was given full value. Apparatus listed as in fair condition was given one-

half value. Apparatus listed as junk was given no value. On this scale the present value of the equipment owned by each school was estimated.

The equipment available for carrying on particular experiments and demonstrations was determined by inspecting the list of apparatus for a particular school and determining from the list if sufficient apparatus was available for performing the experiments in question. If the school had equipment listed as in good condition for a particular experiment it was included in a column of satisfactory performance. If most of the apparatus for a particular experiment was listed as in fair condition the performance of that experiment was checked in a column of poor performance. If there was no apparatus or the apparatus was listed as junk by the teacher, the experiment was checked under a column showing inability to perform. The list of experiments and demonstrations used was that published in the latest state course of study for physics (1927). There are fifty-three of these experiments and demonstrations recommended. The list in the table given in this paper uses the terminology and the order of the list in the Missouri State Course of Study. In this list the first twenty-five are recommended as individual or small group experiments. The following twelve are recommended as teacher demonstrations. The remainder are left to be done either as individual or demonstration experiments.

The data secured may be summarized into a picture of conditions underlying physics teaching in this group of village high schools. Much physics teaching, and other science teaching, is being done in quite small high schools. The very small schools are apparently doing a larger proportion of science teaching than the larger schools of the group. Physics and general science are the sciences taught in these village schools in Missouri.

The schools are not constructed to adequately provide for science instruction. Only six schools out of forty-two are equipped with running water, gas and alternating current. Less than half of the schools have laboratories equipped with running water. Only about one fourth have demonstration desks equipped with running water.

The median replacement value of apparatus is $510. This falls to a median present value of $336. The median replace-

ment value of laboratory and demonstration furniture is $260. Three schools are teaching physics with no such furniture. The median expenditure for apparatus during twelve months is $67.50. Four schools spent nothing and nine others spent less than $50 each. If the estimation of present value is at all accurate, the median depreciation of apparatus is $174. The actual depreciation is probably greater. With expenditures of $67.50 per year it would take the median school three years to bring its equipment back to its present replacement value, providing no further depreciation took place in these three years. Apparently the equipment for physics teaching in these schools is steadily going down hill.

None of the schools studied have any apparatus for performing three of the experiments and demonstrations recommended in the state syllabus. More than half of the schools are so poorly equipped as to be able to do poorly or not at all 16 of the recommended experiments and demonstrations. This is nearly one third of the list. One fourth or more of the schools can do poorly or not at all 35 out of 53 of these experiments and demonstrations. There is little evidence to show that these schools are better equipped to do demonstration work than they are to do laboratory instruction.

In spite of the above conditions, the investment per pupil enrolled in physics (median $17.46) is undoubtedly high as compared with the investment per pupil of other types of subject-matter.

What significance for physics teachers, or other teachers of science, may be attached to these conditions? It is indeed difficult to draw definite conclusions concerning what should be done to improve such teaching conditions. It is doubtful if any suggestions for remedy may be scientifically derived from such data. Certain questions and problems may, however, be presented as growing out of such conditions. These may suggest possible experimental investigation leading to improvement.

Should small high schools, similar to the eighteen considered in this investigation, attempt to teach physics at all? These schools have less than one hundred pupils. Several have only three teachers. Their equipment is poor. For the most part they lack gas and running water as regular equipment. Should these schools be limited to general science as a pro-

gram of science instruction? Should they be advised to substitute a course in biology for that in physics on the assumption that biology can be done satisfactorily with less expensive equipment than physics.

Certain other factors have a direct bearing upon this group of problems. It is doubtful if these schools are better equipped to do better general science than they are to do physics. Our tabulations of duplicate use of apparatus would indicate this. Certainly, schools without running water, gas and electricity are equally handicapped in attempting to do general science. In three teacher schools the same problem of an adequately trained teacher would present itself. This might be even more acute since general science teaching requires a broader training than physics teaching alone. Something might be done over a long period to change the trend in such schools from physics to biology. Who knows if this is wise or unwise?

In connection with criticisms of attempts at science teaching in very small high schools it is necessary to remember that in the schools studied the very small schools as a group were actually training more boys and girls in physics than were the four larger schools with considerably more people enrolled. Perhaps the only remedy for these smaller schools lies in the administrative solutions of consolidation of small schools into larger units and better general finance of schools.

The decreased proportion of enrollment of pupils in physics in the larger schools of the group presents a problem. This reduced proportion seems not to be wholly explainable upon the grounds of wider range of offerings in other sciences in the larger schools. One school with an enrollment of 400 had only five pupils in physics. There were 36 in chemistry and none in biology. The total enrollment of 41 is still small. The wider range seems not to be an entire explanation. The larger schools have better equipment than the very small schools as a general rule. Is something wrong with our instruction in physics that we do not in a mechanical age attract more pupils into our courses? Poor equipment is obviously not the answer to this, since the four larger schools are comparatively well equipped. Perhaps a modification of science instruction to better adapt it to the needs of young people is the answer. Can it be that the very small schools are doing this better than their supposedly superior neighbors?

It would seem almost hopeless, under present conditions, for most of the schools in the whole group studied to build up an adequate laboratory for individual laboratory instruction *of the type now expected of schools.* If this is true, it seems wise on the basis of simple economy and expediency to recommend that such schools spend their limited funds for more satisfactory demonstration apparatus rather than trying to spread the funds thinly over inadequate individual laboratory equipment. This is especially true since modern educational experimentation seems to point in the direction of lecture demonstration as a satisfactory procedure for science instruction.

Initial expenditures for such a program should include school water supply systems, adequate plumbing, and some satisfactory source of laboratory heat in those schools not now so equipped. An inexpensive demonstration desk and a supply case should also be provided. Such equipment should provide for combinations that would permit of duplicate use for all the sciences taught in a small school. After some equipment adapted to demonstration is secured it is possible that, for apparatus not handled by pupils, $100 per year would provide for replacements and some yearly growth, at least beyond present standards.

In attempting instruction by demonstration it is possible that increased use of visual apparatus such as good charts, lantern slides, lantern slide diagrams and enlargements, and moving pictures would make an adequate substitute for much of the illustrative and explanatory "laboratory experiments" now carried on by pupils. This point suggests an excellent problem for investigation for some of the people now concerned with problems of science instruction.

Perhaps the instruction in physics in small schools with relatively poor equipment secures as good results, in terms of pupil learning, as does the instruction in larger schools with better equipment. This point needs investigation by measuring the results of physics, and other science teaching, in poorly and in well-equipped schools. Further investigation needs to be made of the possibility in physics training carried on by good teachers with relatively poor equipment. Perhaps our assumption of considerable material equipment, *of the customary type,* is a myth. Can physics and other school sciences

be taught satisfactorily with little or no traditional equipment? Perhaps we have grown to lean too heavily on purely artificial crutches in our traditional science teaching.

All this seems ultimately to lead back to the cry for a renaissance in high school science instruction. Most experiments in high school physics laboratories are not experiments but merely illustrations of something which pupils have read or been told. Very often these experiments illustrate things which pupils know perfectly well from homely everyday experience. There is often no point to finely drawn distinctions of the quantitative sort in experiments. Most high school pupils are not going to be professional physicists. Why raise finely drawn distinctions between illustrations done by the pupils by their own manipulations? Why not use the observations of pupils as data? Why not use the equipment of the home, the school, the street and the whole out-of-doors as laboratory apparatus? Why not set some problems of application of accepted principles and laws and now and then permit a pupil to do a real piece of experimentation where the conclusion is not drawn for him in the beginning?

Let us set ourselves, as research workers in science teaching, the problem of devising simpler and more worth-while demonstrations and experiments that can be done with very simple and homely apparatus, or none at all. Let us then experimentally evaluate this material by actual teaching experiments. Then perhaps we can point a way out of darkness for small high schools and larger ones scattered over our whole country.

APPARATUS AVAILABLE FOR PHYSICS INSTRUCTION IN NORTHEAST MISSOURI HIGH SCHOOLS

RALPH K. WATKINS, University of Missouri
JOHN HARTY, N. E. Mo. State Teachers College

TABLE NO. I

Replacement Value of Physics Apparatus in 39 First Class High Schools of Northeast Missouri

Value	: No. Schools
Over $1,000	2
900 - 999	1
800 - 899	3
700 - 799	0
600 - 699	6
500 - 599	9
400 - 499	9
300 - 399	5
200 - 299	4

Maximum value $1376
Minimum value 246
Median value 510

TABLE NO. II

Estimated Present Value of Physics Apparatus in 39 First Class High Schools of Northeast Missouri

Value	: No. Schools
Over $1,000	0
900 - 999	1
800 - 899	0
700 - 799	1
600 - 699	1
500 - 599	2
400 - 499	5
300 - 399	16
200 - 299	9
100 - 199	3
Below 100	1

Maximum value $963
Minimum value 86
Median value 336

Maximum replacement value of physics apparatus per pupil enrolled in physics	$130.39
Minimum replacement value of physics apparatus per pupil enrolled in physics	3.67
Median replacement value of physics apparatus per pupil enrolled in physics	17.46

TABLE NO. III.

Replacement Value of Physics Laboratory Furniture in 42 First Class High Schools of Northeast Missouri

Value	: No. Schools
$700 - 799	1
600 - 699	0
500 - 599	4
400 - 499	2
300 - 399	12
200 - 299	9
100 - 199	9
1 - 99	2
0	3

Maximum $760
Minimum 0
Median 260

TABLE NO. IV.

Amount Spent for Physics Apparatus in 12 Months by 42 First Class High Schools of Northeast Missouri

Amount spent	: No. Schools
Above $500	1
400 - 499	0
300 - 399	0
200 - 299	4
100 - 199	10
50 - 99	14
1 - 49	9
0 -	4

Maximum $520
Minimum 0
Median 67.50

TABLE NO. V.

Fixed Equipment for Science Instruction in 42 First Class High Schools of Northeast Missouri

Type of equipment	No. Schools	% of Schools
Running water in laboratory	20	47
Running water for demonstration	11	24
City gas in laboratory	7	17
City gas for demonstration	6	14
A. C. current in laboratory	32	76
A. C. current for demonstration	21	50
D. C. current in laboratory	2	5
D. C. current for demonstration	1	2
Special provision for gas supply in laboratory or for demonstration	0	0
Completely equipped with water, gas and A. C. current	6	14

TABLE NO. VI.

Experiments in Physics which 42 First Class High Schools in Northeast Missouri are Equipped to Perform

Experiment	No. Schools Satis-factorily	Number Schools Poorly	No. not at all	% Poorly or not
Measurements, linear, volume, mass	17	16	9	60
Density of solids	26	7	9	40
Specific gravity of liquids	24	2	16	43
Hooke's law	0	0	42	100
Composition and resolution of forces	40	0	2	5
Pulley, block and tackle	42	0	0	0
Inclined plane	37	2	3	12
Levers	32	10	0	24
Laws of pendulum	39	0	3	7
Specific heat	36	0	6	14
Determination of boiling point	29	0	13	31
Heat of fusion of ice	37	0	5	12
Heat of vaporization of water	0	29	13	100
Laws of vibrating strings	26	0	16	40
Image in a plane mirror	28	0	14	33
Index of refraction of glass	30	0	12	30
Focal length of concave mirror	15	20	7	64
Lines of magnetic induction	26	0	16	40
Field about a permanent magnet	39	0	3	7
Study of voltaic cell	26	1	15	40
Magnetic effect of electric current	26	1	15	40

TABLE NO. VI—Continued

Experiment	No. Schools Satis- factorily	Number Schools Poorly	No. not at all	% Poorly or not
Study of electro-magnet	41	0	1	2
Magnetic effect of coils carrying a current	29	0	13	31
Laws of resistance	30	0	12	30
Ohm's law	33	0	9	21
Weight of air	9	29	4	80
Linear expansion of metals	0	0	42	100
Expansion of gases	18	0	24	57
Study of compound microscope	33	0	9	21
Study of telescope	33	0	9	21
Study of electric generator	14	0	28	67
Study of electric motor	24	0	18	43
Study of transformer	16	0	26	62
Study of telephone	17	6	19	61
Study of radiations	0	0	42	100
Study of telegraph	35	0	7	17
Study of radio	12	0	30	71
Boyle's law	7	23	12	83
Wheel and axle	26	0	16	40
Study of thermometers	42	0	0	0
Determination of dew point	20	17	5	52
Mechanical equivalent of heat	20	0	22	52
Velocity of sound	31	0	11	26
Wave length of sound	31	0	11	26
Image formation through concave and convex lens	35	5	2	17
Magnifying power of simple lens	40	0	2	5
Study of photometer	26	0	16	40
Static electricity	21	19	2	50
Electromotive force	31	1	10	26
Internal resistance of a cell	27	1	14	36
Study of induced currents	23	1	18	45
Fall of potential along a conductor	32	1	9	23
Heating effect of an electric current	32	1	9	23

The Conduct of Courses in the Teaching of High School Chemistry[1]

J. O. Frank
State Teachers College, Oshkosh, Wis.

In some earlier pages[2] the writer has attempted to show that the objectives and the content of certain courses in the teaching of science ought to be. Since the appearance of these pages the writer has, several times, prepared for individuals a plan for conducting the courses described. This article may be considered a continuation of the earlier papers. It is prepared in the belief that those concerned in any way in courses in the teaching of science, whether students or teachers, will be interested in the point of view and the plan of conducting courses in science teaching, as these are here presented.

First Things First

Any course in the teaching of science ought to be founded on a philosophy of education which can be expressed in a clear-cut set of aims or ultimate objectives. These ought to be sharply defined in the mind of the person planning the course, or set down on paper for study by students and instructor alike. In planning any course, in addition to well defined ultimate objectives, the instructor should have in mind a very large number of smaller, more easily understood and more concrete goals which might be called intermediate objectives, and which if successfully accomplished would make certain the realization of the larger and perhaps more abstract ultimate objectives. Further, in planning the course, the competent instructor will think of the aims of his course in terms of the *activities* necessary to accomplish them. This means that he must plan a very definite sequence of activities for himself and for the members of his class, and these activities must be such as to make certain the accomplishment of intermediate and ultimate aims. Let us assume that the instructor has clearly in mind what he wants his course to accomplish and that he has outlined the materials of his course. Let us attempt to visualize the job of

1 The plan may be adapted to courses in the teaching of Biology, Physics or General Science, as well.
2 General Science Quarterly, March, 1928, pages 431-443, and Journal of Chemical Education, March, 1928, pages 326-336.

planning the activities for the members of his class and for himself. He knows that his class will be made up of a heterogeneous group of people; some experienced teachers and some inexperienced prospective teachers; some well acquainted with teaching problems and some with no knowledge of modern educational methods whatever; some well versed in the subject-matter they wish to get ready to teach and others who hope to learn how to teach and expect to learn the subject-matter while teaching it. The competent instructor knows that very early in his course he must gather much information about the individual members of his class, so that he can intelligibly plan his work to fit their needs. (It is true that there are still a few instructors who have courses which they want to give, and they give them without regard to the varying needs of their classes from year to year.) Every instructor ought to sense a few clearly defined things he must get done if he is to accomplish his aims and leave with his class the permanent values which his course makes possible. These must be undertaken in about the following sequence:

1. The instructor ought to put out a questionnaire which will give information as to the general preparation, previous experience, etc., of the members of the class.
2. By lectures, assigned reading, individual reports, and the like, an attempt should be made to bring the members of the class to an understanding of the present status of chemistry as a high school subject. (It will be impossible to build without a foundation to build upon. Some knowledge of the history of the subject as a part of the high school curriculum will be necessary.)
3. The next goal will be the development of a clear understanding of present-day problems in chemistry teaching.
4. With the problems known, their solution becomes of interest. There must be developed an understanding of the scientific method of problem solving. There must be presented a number of examples of the methods used in scientfic investigation of educational problems. Some practice in the use of the scientifice method must be given and some appreciation of its possibilities developed.
5. With the background and historical aspects well in mind, with the problems defined, and with the method of attack understood, the individual problems involved in the teaching of chemistry, or any other science, may now be treated. A few of these are suggested under instruction activities (7) below.

With these jobs in mind, and with the objectives of the course before us, let us suggest the series of activities which might be demanded of the instructor and of the members of the class:

INSTRUCTOR'S ACTIVITIES
(In approximate sequence)

1. Gather information about class and define its needs.

2. Instruct the members of the class in methods of work. Give information as to ground to be covered, etc.

3. Carry responsibility for inaugurating activities of students.

4. Give lectures and show background and present status of the subject; also define present-day problems.

5. Bring class into desirable attitude toward activities needed to accomplish objectives.

6. Stimulate interest in the activities and assist in carrying them out when necessary.

7. Appoint committees to investigate and report on special problems, such as:

   a. Objectives of high school chemistry.
   b. Selection and organization of subject-matter.
   c. Text-books.
   d. The contract method.
   e. The demonstration method.
   f. Evaluation of methods of teaching.
   g. The laboratory.
   h. Special aids to teaching chemistry.
   i. The library.
   j. The teacher's problems.
   k. Time and place of high school chemistry.
   l. Sequence of the high school sciences; etc., etc.

8. Outline instructions to these committees, arrange for their first meeting, see that they do work required and make reports.

9. Give lectures on fundamentals of subject-matter—lead discussion—raise problems—present evidence—tell what is being done—answer questions.

10. Hold conferences with individual students, to help with their own problems.

11. Give necessary quizzes and examinations; read and correct papers.

12. Assist and guide committees and individuals in the solution of problems.

13. Assemble and co-ordinate all materials gathered by students and instructor. Have outlines mimeographed, get all material in such form as to make it available to all students of the class.

STUDENT ACTIVITIES

1. Required readings, bringing the students into contact with the best in the literature of the subject, and attempting to interest him to the extent that he will read further—establishing desirable attitudes and habits, as well as acquaintance with the literature.

Objectives:—

1. **Information.**
2. **Understanding.**
3. **Habits.**
4. **Attitudes.**

(Students are usually required to keep notes on reading—or reading cards)

2. Special reports to give an understanding of, and drill in, research methods.

Job. 1: Chiefly gathering, classifying, and interpreting information on a special subject or phase of the subject.

Job 2: Gather information, classifying it, interpreting it in terms of the problems it raises, definitions of these problems, plans for investigations leading to their solution, and beginning work (at least) on their solution. (The term paper.)

Objectives:—

1. **Information.**
2. **Practice in methods of investigation.**
3. **Stimulus to worthwhile activity after leaving school.**
4. **Widened viewpoint.**
5. **Attitude of the investigator.**
6. **Open mind and willingness to investigate problems of teaching.**
7. **Interest in wider educational problems.**
8. **Sympathetic interest in the work of the best educators and institutions.**
9. **Stimulus to more active interest in lectures and class discussions.**

3. Participation in class activities.

(a) Reports to class on own experiences.

(b) Questions prepared and presented to the instructor at any time, and to be answered in class, in committee, or in conference.

(c) Note books.

(d) Committee work. Each student is to be a member of one or more committees, to take active part in discussions, the investigations, and in the preparation of the reports of these committees.

Objectives:—The general objectives of the course.

4. Preparation of papers indicating:

(a) Views as to personal teaching problems at beginning.

(b) Views as to personal problems—with plans for their solution at end.

(c) Reports on any type of teaching believed to be especially efficient.

Objectives:—

1. Develop ability and give practice in making clearcut, clean, well organized reports, both written and oral.
2. Give assistance in solving personal problems.
3. Help define own problems.

5. Tests and questionnaires:

(a) Exploratory tests and questionnaire at the beginning to determine objectives and best procedure for the course.

(b) Tests and quizzes to determine progress, to stimulate proper activities, and to enforce active preparation for lecture and discussion.

(c) Tests to determine quality of work done, progress made, and standards reached—as a basis for awarding credit.

Objectives:—General objectives of the course.

The above activities have been suggested for instructors and students in courses in the teaching of chemistry, with the thought that they may help present a working plan of one method of conducting such courses, and perhaps serve as a point of departure for a discussion of several problems which have not yet been satisfactorily solved, to wit:

1. What ought courses in the teaching of science to accomplish?
2. What subject-matter ought to be treated in such courses?
3. How conduct such courses to accomplish most worth-while results?

Finally, a few suggestions may be given to those who are planning courses in the teaching of science.

FACTORS AFFECTING THE SUCCESS OF A COURSE IN THE TEACHING OF ANY SCIENCE

1. The course must deal with the materials needed by the students enrolled. It should not consist of a fixed body of material all previously arranged and without regard to the needs of the class.

2. All students must have at all times *work to do* which is clearly related to their interests, and which will result in growing power on their part.

3. The course must deal with the broader aspects, so as to give the impression of a well unified whole, but also with the specific problems which are uppermost in the students' minds.

4. An impression of stability and concreteness is produced and greater values obtained when the students are given mimeographed outlines, lists and briefs, samples of tests and teaching outlines, reprints of reports and investigations, and the like, at proper times in the course.

5. An impression of finish and a feeling of confidence is produced when a working outline of the course can be given near the beginning of the term or semester.

6. As far as possible, good principles of teaching—as defined in the course—ought to be exemplified by the methods used in the course.

Biology in Rural High Schools Correlated with Farm, Home and Community*

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GENERAL CONSIDERATIONS

Biology in any school of secondary grade should be a "civic" science dealing most intimately with the affairs of the home and community. In the smaller high schools, especially in a rural environment, the possibilities for such correlation with home life, local industry, and community affairs are more obvious. In addition to the features which are essential in all communities, other special opportunities are presented. The presence of considerable numbers of pupils from farm homes, and especially of boys who study agriculture, introduces responsibilities not found in an equal degree elsewhere.

Stated briefly, the course should deal with plant and animal life, with human physiology and hygiene, with community sanitation and should stress the local applications. It should adapt itself to a seasonal development, utilizing individual interests and prevalent problems of farm, home and community. The *current projects* of pupils in agriculture and household arts will furnish a basis and motivation for a large proportion of the most vital science study. Farming is not an occupation alone but it is a mode of life which deals peren-

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* A modification of the biology section of the work of the Committee on Science for Agricultural Pupils in Massachusetts prepared in 1927. It is not the final work, but is put out as a report of progress.

nially with plant and animal life in their most interesting aspects.

To put the problem in a negative way, such a course in a rural section is *not* primarily concerned with *urban* affairs, should not be an abridgment of a college course in biology nor should it be composed of *separate brief courses* in botany, zoology and other biological sciences.

In the smaller high schools, general science and biology are frequently taught on alternate years to freshmen and sophomores combined. In larger schools both courses are taught each year, usually with general science for freshmen and biology for sophomores, although this order is sometimes reversed.

It seems best in this discussion to assume that *biology* is a *second year subject* but not to assume that the general science of the first year has greatly modified the problem of presenting biology.

In the following pages will be found a suggested outline, (not a syllabus), with copies of the outlines used in certain schools in Massachusetts. A section is devoted to the factors involved in selecting and arranging topics and problems. Specimen developments of a few lessons and some projects follow to illustrate method. Additional advice on special methods, with sources of helpful material are given. Since no single textbook incorporates all of the factors previously mentioned, the utilization of the textbooks listed requires clear vision of objectives on the part of a teacher. To supplement the common textbook for each pupil, (which is required under certain types of school organization), other texts and references are listed for individual assignments.

WHAT SHALL BE TAUGHT IN THE COURSE

Since well-taught courses in biology would not be identical in any two schools or in two different years in the same school, it is obviously not desirable to set up a syllabus. The person who has the qualifications for teaching such a course will be more helped by a consideration of the criteria for selecting and for arranging such parts of the wealth of biological material as are best fitted to the needs of his class.

As a basis for discussing these factors involved in selecting and arranging the topics and problems in this course we present a typical outline which has been used successfully (about

as it stands) by teachers of farm and rural pupils. It contemplates the presence of both agricultural and home-making pupils, (possibly some others).

The outline will not without some modification fit any other locality but must be rearranged in accordance with the principles discussed in the section which immediately follows the outline.

It will be observed that all of the topics selected have been set up as problems. The briefly stated problem like any brief title may not be adequately explanatory. This particular difficulty is treated separately since this outline is only illustrative. The method of doing the work should clarify this point.

A SPECIMEN COURSE IN APPLIED BIOLOGY

(For Second Year Pupils in Rural High Schools)

I. EARLY FALL PROBLEMS.

(Before Heavy Freezing)
The Order may be changed.

The problems.	Lessons to be learned.
1. How can we procure the best home-grown seeds?	1. Fruit and seeds. First contact for background.
2. Why is some seed corn "mixed"?	2. Two types of flowers in corn. Necessity of field selection of most seed. Parentage.
3. What are the essential parts of the flower involved in seed production?	3. Basis of seed production.
4. What devices has nature to insure cross pollination?	4. Connecting problems 2 and 5. Field work mostly.
5. How do flowers differ in these essential parts? In other respects?	5. The typical flower.
6. In what ways are certain cultivated plants related to each other?	6. Family and generic resemblances. Field introduction.
7. Are any of the weeds related to any of the crops?	7. Same as 6 continued. Introduction to weeds.
8. What is a weed? In what ways do weeds reduce production?	8. Study of weeds and struggle for existence.
9. Make a list of weeds which are found to have been troublesome locally and a list of the crops injured by them.	9. Systematic tabulation and basis of review.

10. How are the weeds which are listed best controlled?	10. Man's interference with "survival."
11. What happens to the corn in the silo? In what way is the silage better than corn fodder?	11. Fermentation and preservation. Non-technical consideration of food values in silage.
12. What methods of preserving foods correspond to silage making.	12. Same carried over to "dill" pickles, sauerkraut, etc.
13. Why does bread mold? Do other foods mold also?	13. Developed from 12. The conditions favoring the germination of spores.
14. In what other ways do foods spoil? What do we use to delay this in September?	14. Other bacterial and fungus spoilage. *Refrigeration.*
15. How may foods be sterilized for current use? For preservation?	15. Elementary principles of control of bacteria. Science involved in canning.
16. What happens when fruit juices "sour?"	16. Current experience in fermentation explained. Alcoholic and acetic.
17. What is the matter with the apples?	17. Culled apples have been taken from the grader. Recognition of disease and insect damage.
18. In what ways do insects do harm to crops? What does this have to do with different methods of control?	18. Field study, collection and recording. First approach.
19. How do insects differ from other "bugs?" Why do we need to distinguish them with some exactness?	19. Second step in recognition of insect pests.
20. What other injuries to apples not caused by insects? How caused? Could any of them be prevented?	20. Fungus diseases which render apples unsalable.
21. What causes the smut on corn? What harm does it do? Can it be controlled?	21. Parallel to 20. Found on same field trips.
22. What is the botanical type of fruit in each kind we use as food?	22. Current fruits. Formal botany. Appreciation of terms in common reading.
23. In what stages of its life history do we find each insect now? What is its life cycle?	23. First lesson in insect life stages. Note for each insect readily found and especially for those which are of economic importance.
24. Which of the trees do we know? Which are good street trees? Which are good for lumber? For wood? etc.	24. Recognition of trees before leaves are all gone.
25. What soil conditions are indicated by crops in some fields?	25. Basis for further knowledge of soils and plant feeding. Collect samples of soil and label to be used in winter lessons.
26. Why are clover, alfalfa and such crops highly regarded? How do they benefit soils?	26. The legumes in their relation to atmospheric nitrogen.

II. LATE FALL PROBLEMS.

(After killing frosts but before the permanent snow fall.)

The problems.	Lessons to be learned.
1. What have you observed begins to happen to the different forms of animal life we have seen this fall? List these and compare.	1. Continuing study of gradual hibernation, color changes, etc.
2. How is nature preparing different seeds for winter?	2. Study of seed structure, protection, etc. (Collect, list and compare.) Preparatory to winter study.
3. How does nature insure the scattering of seeds?	3. Field and laboratory study of seed dispersal.
4. What organs of the plants do we eat in the case of each garden vegetable as usually served? What methods are used to improve each as to size or quality?	4. Preliminary study of parts of plant to correlate with "winter storage" of vegetables.
5. How should different vegetables and fruits be stored for home use in winter?	5. Study of factors for ideal dormant period of vegetables.
6. In selecting the poultry flock for raising a new lot of chickens, what should I know about heredity?	6. To correlate with the selection of breeding stock. First approach to "heredity."
7. What methods of propagation are used for each garden vegetable? In which cases are seed not likely to come "true to variety?"	7. Same as 6 but on the vegetable side. Elements applied to seed, tuber, graft, cutting, etc.
8. What special insect control measures are very effective late in the fall? What facts in insect life are involved?	8. Late sanitation. Exposure of dormant insects to the weather.
9. What damage do rats cause? How may they be exterminated?	9. Facing period of great loss in poultry pen and in stored crops.
10. What causes milk to sour? How can it be prevented? In what other ways does milk spoil? Is "soured" milk harmful?	10. First steps in clean milk production. Factors of bacterial development.
11. What may make a milk supply unsafe? What legal restrictions? What precautions recommended?	11. Same continued to cover standard practice.
12. What is the normal composition of milk? What variations legal? How tested?	12. Leading to study of milk as food, and to testing and judging milk.
13. How are milk samples judged?	13. Flavors, cleanliness and sanitary precaution only. Not composition.

III. WINTER PROBLEMS.

(Dormant season problems, the order not very important. Some options and individual assignments are expected.)

The problems.	Lessons to be learned.
1. What birds are still with us in winter? How do they live?	1. Recognition of few birds now present. Start a list to which will be added the returning migrants with dates.
2. Which birds do harm in winter? How? Which are beneficial? How?	2. Beginning study of benefits and damage. Start table.
3. How recognize trees in winter? What tree is that? What is it good for?	3. Continuing fall study to fix identity of all common trees.
4. How are our schoolrooms heated, and how ventilated? Why are these methods used?	4. Preliminary observations on basis of sanitation on the side of respiration.
5. What different methods do our homes use for heating and ventilating?	5. Same. Home situation. Use score cards. Bring in reports and discuss.
6. What methods of ventilating are considered ideal? What principles are involved?	6. Principles. (Some elementary physics involved.)
7. What is the course of circulation of the blood? Why each part?	7. From respiration to circulation. Physiology.
8. What habits tend to keep the circulation good and the blood pure? Score card suggested.	8. Same, hygiene.
9. What is the composition of the blood? What is the work of each part?	9. Obvious.
10. How is the blood kept up to the normal standard? As to oxygen. As to food. As to corpuscles, etc.	10. Hygiene.
11. What habits or practices of the family tend to reduce disease in the home? Home sanitation. Use score card.	11. More general.
12. In what ways do some insects cause diseases? (Or transmit them.)	12. Malaria and typhoid, illustrations. Questions may be reversed.
13. What "nutrients" predominate in various plants or parts of plants which we use for foods?	13. Laboratory study of proteins, carbohydrates, fats, etc. as a basis of nutrition and also of "plant food."
14. Into what general groups may the essential parts of the food of human and other animals be arranged? How may we in a rough way detect and estimate the amount of each in any food?	14. Laboratory tests of typical foods and reference study of clinch "nutrients." Several laboratory exercises involved covering several days.
15. What balance of foods is best for humans? Why?	15. Principles of a balanced ration.

16. Why are the nitrogenous or protein foods for stock or for humans usually more expensive than other foods?	16. Obvious. Applications to feeds and fertilizers. Correlate with "legumes."
17. In what ways should the diet of a young child or a growing animal (chicken, calf or pig) differ from that of an adult? Why?	17. Natural extension of 16.
18. What relation exists between the food requirements for persons and the balanced ration for cows or other farm animals?	18. Obvious.
19. What can we know about the *vitamines* required for good health? What is advised in this particular?	19. Selected readings to discover present safe position of the layman. Known and estimated.
20. How do our digestive organs prepare for the blood starch, sugar, protein, etc.? (Several problems.)	20. A study of the processes of digestion based on previous problems.
21. How does the food get into the blood?	21. Osmosis. A good place to develop this topic fully.
22. Compare the digestive systems of a man, cow, fowl, pig, and lower animals. In what ways are all alike? How different?	22. Obvious. Of varying importance in different classes.
23. What is the harm in adulterated foods? In stimulants? In drugs? How can some of these be recognized? What laws are intended to protect us from these?	23. Obvious. Several lessons possible.
24. What is the source of each constituent of plant food needed to produce the part we require?	24. Emphasis on the air and the minerals in the soil. Cycles of N and CO_2
25. Can the N of the air be tapped to save the expense in fertilizers? What practices are most economical in plant husbandry?	25. Follows 24 naturally. To discover the relative expensiveness of various parts of foods and fertilizers. Leads to nitrogen cycles involving legumes, also manure saving.
26. How does a plant manufacture the food it stores in tuber, seed, etc.?	26. Follows 24 naturally. Photo-synthesis experiments. Test tubers etc. for starch. Show function of chlorophyl in leaf.
27. How does plant food circulate in the plant?	27. Cell structure, capillarity, etc.
28. What similarity in the sanitation of a poultry house, a stable and a home? What differences?	28. General sanitation of buildings.
29. What methods are used in sterilizing greenhouses? Why? Which of these can be used in poultry houses? Which in homes?	29. Special disinfection or fumigation.
30. How can we best fight infectious diseases?	30. Other measures in contagious diseases.

31. What is meant by immunity as applied to man, other animals or to plants? How may this be acquired?	31. Acquired immunity.
32. Why is milk so frequently a source or a medium for spreading a disease? What diseases? How can this be minimized?	32. Special sources of contamination. Milk as a carrier.
33. In what different ways do some bacteria affect our lives? How do the bacteria do this?	33. A review and summary on bacteria.
34. What is the hygiene of healthy muscles? How grow strong? How keep in good weight?	34. Obvious.
35. What first aid is advised for a drowning person? Why each step? Compare with other first aid. Under what other circumstances is artificial respiration required?	35. First aid in asphyxiation. Practice.
36. What shall be done for a boy who is cut while working in the shop?	36. First aid; cuts. Practice.
37. What shall be done for the girl who is burned in the kitchen? What special first aid to one whose clothing is afire and is badly burned about the body?	37. First aid; burns. Practice.
38. What is the relation between our sense organs and our learning in school? Why is accurate observation essential?	38. The senses. A series depending on time.
39. How do our "senses" give us information? Structure, function, physiology and hygiene of each sense organ suggested.	39. As in 38.
40. What care should we give our nervous systems? Why?	40. Lesson on good habits.
41. How are body wastes removed from the system? How are the tissues replaced? What is the proper care of the systems which eliminate waste?	41. Obvious.
42. What are the present ideas as to the requirements of the person (or the animal) for sunlight?	42. Vitamines, ultra-violet rays, etc.

IV. LATE WINTER PROBLEMS.

(Preparation for spring operations becomes very important.)

The problems	Lessons to be learned.
1. How are animals classified for the purpose of study?	1. Brief systematic arrangement.
2. The demands of man and other animals on the atmosphere have what relation to the demands of plants?	2. Work out the Carbon cycle.

3. What insect pests may be fought in midwinter? How?	3. Dormant sprays. Clean up campaigns. Tent caterpillars, etc.
4. What microscopic or very small plants or animals play an important part in our lives? How? How controlled?	4. Amoeba, yeast, molds, rusts, etc. New forms and summary of the studies previously made.
5. How does the chicken develop each day from the time it is put in the incubator until it is hatched? How does the period compare with that of other birds?	5. Laboratory study from the eggs. Drawings each period suggested.
6. How are the trees prepared to live in freezing weather?	6. To observe and explain the structure of winter buds on trees.
7. Of what is the plant composed?	7. The bio-chemistry of the stem, the leaf, the fruit.
8. What methods of grafting apple trees shall we use? And why?	8. The principles involved in grafting.
9. How does the process of osmosis fit into plant life? Into animal life?	9. Study of osmosis. More detailed than previous study.
10. What effect have light, gravity, etc. on the direction of plant growth?	10. Laboratory study of heliotropism, etc.
11. What is the purpose of the root of a plant? How does it do its work?	11. Laboratory study of roots.
12. How does the root do its work of taking up water and food? Osmosis etc.	12. Continuing 11.
13. How does a seed germinate?	13. Laboratory study of the "factors" of germination.
14. What difference in seeds and in classes of plants do we discover in germinating seeds?	14. Mono-and di-cotyledons.
15. What other differences do we find in dicotlyedons and mono-cotyledons?	15. Stem, leaf, flower and other differences.
16. In what ways do different kinds of plant stems vary in structure? In physiology.	16. Grows out of 15.
17. How are seeds tested for viability and vigor? How can seeds be handled so as to secure maximum germination and vigor?	17. Laboratory tests.
18. How are seeds tested for percentage of germination?	18. Work out in laboratory.
19. How are seeds tested for purity?	19. Work out in laboratory.
20. What are the legal requirements regarding seed purity in this state? How have our seeds rated under this law? What standards are set by other states?	20. Investigation.

21. What conditions are favorable for germination of seeds? What are absolutely necessary? A series of experiments indicated. What bearing has this on planting?	21. Continuing 13 as laboratory study.
22. How long can the seedling grow from food stored in the cotyledons?	22. Laboratory test.
23. For seedling growth (beyond the stored food) what plant foods are "limiting factors?"	23. Laboratory tests of essential elements, especially C. N. P. and K.
24. What great men in biological sciences should we know? What did each do for us?	24. Scatter this through several weeks. Partly review.
25. How do very simple plants and animals resemble each other? How do simple plants differ from simple animals?	25. Obvious.
26. In what ways are any insects beneficial to human beings?	26. Reference reading.
27. In what ways do "higher" animals differ from the "lower" animals? In what respects are they identical?	27. Obvious.
28. Of all the orders or families of animals, which affect us most in our community?	28. Comparative zoology. List the orders, animals and influence on us. Tabulate for comparison.
29. Why does too concentrated commercial fertilizer kill a plant?	29. Another angle on osmosis, etc.
30. What relation between soil acidity and plant growth?	30. Study "project" soils.

V. SPRING PROBLEMS.

The problems	Lessons to be learned.
1. What principles are involved in the use of hotbeds? What relation has the source of heat to some previous lessons we have learned?	1. Heat from bacterial action. Favorable conditions.
2. What biological principles are involved in pruning apple trees? What bearing does each have on the methods of pruning?	2. Physiology of the plant stem.
3. What flowers bloom first? In what order do the others follow?	3. Record dates throughout spring. Prepare a chart.
4. What connection may there be between the dates of returning birds and other events such as climatic changes, progress of plant development, etc.?	4. Keep record. Migrations, weather, plant growth, etc.
5. What animal life is observed early in the spring in ponds or other stagnant water?	5. Observe, record, and consult references. Mosquitoes, eggs of frogs, etc.

6. Can I identify the various garden seeds? Can I recognize the weed seeds among them?	6. Follow up of winter study of seed and germination tests.
7. What insects are stirring while the weather is still cold? What are they doing? In what stage are they found?	7. Observe—record.
8. What plants besides apple trees are "hosts" to tent caterpillars? Are these plants related to the apple? What has this to do with control?	8. Observe and record. Record any natural enemies.
9. How can we distinguish the seedlings of different crops, (and especially from weed seedlings)?	9. Observe, sketch, check, review.
10. What insects re harmful to animals, (other than human)? In what ways? How controlled?	10. Spring phases of an earlier study.
11. What weeds survive the winter ready to carry on? What can be done about such weeds?	11. Observation and record as basis of further work.
12. Trace the life history of the garden toad.	12. Observe eggs, tadpoles, etc.
13. What is the life of a honey bee? How do they work? What is their community life?	13. Observe, record, study references.
14. What evidences do we find of beneficial activity on the part of birds in the spring and summer?	14. Start a chart upon which to list all birds observed with harmful and helpful activities actually seen.
15. What bearing does the life history of an insect have on the damage it does? On the control?	15. Observe, record, verify by reading. Such comparison as tent caterpillar and "fall webworm."
16. How may the community water supply be kept safe?	16. Score the local supply. Compare with other supplies.
17. What is the scientific basis of real efforts to improve plants or animals?	17. (Mendel's law etc.) More thorough review of study of heredity as related to current problems. Begun in fall.
18. What methods of propagating plants besides seeding? How is each to be explained?	18. Season steps on current material, based on fall observations.
19. What is the life history of the mushroom? How does this differ from other flowerless plants?	19. Important "systematic" botany of the fungus.
20. What connection is there between the class or family of insects and the methods of control?	20. Insect types and control.
21. How may our forests be protected? How replanted? What can young people do to help?	21. Forest conservation.
22. Of all the plant families or groups, which cause us the greatest amount of trouble?	22. Will review *weeds, fungus diseases* and *bacteria*. Plant relations.

23. Compare the life history of a flowering plant with that of a flowerless plant. What explanation?	23. Plant relations.
24. What plant "families" ought I to recognize? How can they be identified? Which are represented by many plants of economic importance?	24. Study begun in fall. Purpose, recognition in actual work.
25. Why is the water requirement in plant growth in excess of the weight of the plants? Why so great during seed formation?	25. Starch making, water requirement and cultivation.
26. What poisonous and noxious plants in our neighborhood? How recognized? How controlled? How treat the poisoning?	26. Observation, records, discussion.
27. What enemies of the potato plant will probably be present this summer? How shall each be combatted?	27. Pest control. Other crops may be substituted if current season presents them.
28. What are the advantages of transplanting certain vegetables?	28. Phases of plant physiology.
29. What are the requirements of certain plants regarding "cultivation" during the summer? Why is this necessary?	29. Weed control and moisture preservation.

(See Also Supplementary List of Problems.)

The preceding 140 problems are obviously more than any pupil could cover well in the 180-day school year. Hence careful selection and individual assignments are required.

How to select and arrange these problems for most effective learning is the subject for our next consideration on the following pages.

(To be continued)

Are You Taking a Trip Abroad?

EMMA A. HUNT,

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Science teachers traveling abroad for general cultural purposes will find in the more usual travel programs greater emphasis on visiting the repositories of art than on visiting the museums and monuments of science. But there are many things to be seen of great interest in the field of science and the teacher of General Science experiences a greater understanding of the gradual achievements of the scientific spirit in the world, when he stands before the crude apparatus by

which first discoveries were made, and sees these materials from the use of which came the first pronouncements of new truth, side by side with the improved and perfected results which the mind of the scientist has evolved from those small beginnings.

Just as reading an original letter of Burns gives a feeling of having met the man; just as seeing, in Chester, coins bearing Latin inscriptions gives one a far more vivid realization that Romans actually occupied Britain, so does seeing the place where his epochal studies were made make Pasteur more real to one; so, from seeing the materials by which he became convinced of new truth, does Galileo become a living spirit.

Guide books of course hint at the possibilities, but unless one has, beforehand, a well-defined idea of what any place offers in the way of interesting scientific material, time and opportunity are likely to be lacking for getting in touch with them. Your fellow-travelers are probably not well enough versed in science or sufficiently appreciative of crude apparatus or models worked out with precision and skill to desire to accompany you, and you may have to find your way there alone (which can be accomplished, thanks to the amazing interest and courtesy of street-car conductors and policemen). The days and hours, as given in Guide books, when museums are open must be carefully checked up, for errors occur and disappointment results. If letters of admission are required, time must be allowed for the correspondence. Museum visiting is tiring work, as everyone knows, and is best done in short periods.

The Natural History and Science Museums at South Kensington (London) are well worth visiting again and again. The historical material is very interesting, as are the astronomical and mechanical exhibits. The Museum of Practical Geology, possibly now moved from Jermyn Street, has much of interest by way of mineral and paleontological exhibits. At Oxford there are the University and Ashmolean Museums, and at Cambridge the Woodwardian and University Museums. The Observatory at Greenwich may prove of interest. In Paris, no one would want to miss the very impressive tomb of Pasteur in the Pasteur Institute, with its walls bearing an appropriate design in mosaic of the living things he benefited. There is also the Conservatoire des Arts et Métiers where may be seen

apparatus of Lavoisier and Volta. It is interesting to recall that the zero meridian passes through the middle of the Observatory, located near the Luxembourg gardens. The Trocardero has a fine ethnological exhibit. In Florence, in the Museum of Physical and Natural History can be seen the telescope and instruments of Galileo, and the index finger by which he pointed out the heavens. Leigh Hunt wrote that he knew not but what this was the most interesting sight in Florence.

If one has a particular interest in birds, or marine life or something other, he may by a little search find many fine collections. If, before leaving the United States, you take the time to look through some such volumes as Kaempffert's Popular History of American Invention and the Book of Popular Science (15 volumes) you will get suggestions from the illustrations of various statues and historical objects, which you will enjoy looking up. A very good appraisal of science museums can be found in the Encyclopedia Brittanica. Membership in the English Speaking Union is highly desirable, as the offices are extremely willing to suggest and help in making arrangements. The secretary of the Boston Branch Headquarters is Mrs. Helen N. Lawson, and her address 33 Commonwealth Avenue. The London address is Dartmouth House, 37 Charles Street, Berkeley Square, London, W. I.

Your trip abroad can give you not only acquaintance with the treasures of Millet, Da Vinci, Gothic architecture, rewarding enough as these are, but the "living sympathy with the tale we have to tell" should be stronger for having had our imaginations stirred by the sight of tangible things bearing the touch of a Lavoisier, a Faraday, a Copernicus.

A Study of the Relative Effectiveness of Two Methods of Reporting Laboratory Exercises in General Science

FRED W. MOORE, High School, Owosso, Michigan,
CLAUDE J. DYKHOUSE, High School, Plymouth, Michigan,
and FRANCIS D. CURTIS, University of Michigan.

The purpose of this investigation is to compare two methods of reporting laboratory exercises in general science, with respect to effectiveness in teaching subject-matter and to

amount of time consumed in teaching the same subject-matter. Method I was the Conventional Method of reporting laboratory exercises, consisting of four steps: (1) a statement of the problem, (2) the method—a verbal description of the manipulations and the observations, (3) a statement of the conclusions, and (4) a labeled diagram of the apparatus as used. Method II, the Diagram or "moving picture" method, consisted of three steps: (a) a statement of the problem, (2) a series of labeled diagrams showing the various stages in the progress of the exercise, and (4) the conclusion. The following directions for writing up laboratory reports by the two methods and the reports of the same exercise made in accordance with these directions will illustrate the difference between the two methods of reporting:

Verbal directions given the pupils for reporting their laboratory exercises in accordance with Method I, the Conventional Method:

Write the number of the exercise in the middle of the top line of the sheet.

Write your name at the left-hand side of the second line and the date at the right-hand side of the same line.

Copy the problem exactly as it is written upon the blackboard.

Under the heading, Method, tell in complete story form, in your best English, what was done and what happened.

Under the heading, Conclusion, write a complete sentence answering the question asked in the problem and give a reason why you think your conclusion is correct.

Make a pencil diagram, completely labeled, showing how the exercise was performed.

Verbal directions given the pupils for reporting their laboratory exercises in accordance with Method II, the Diagram Method:

Write the number of the exercise in the middle of the top line of the sheet.

Write your name at the left-hand side of the second line and the date at the right-hand side of the same line.

Copy the problem exactly as it is written upon the blackboard.

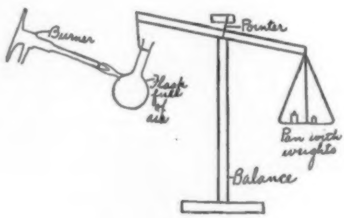
Under the heading, Method, make a series of pencil diagrams showing how the experiment was performed: First show how the apparatus looked at the beginning, then draw a new diagram showing each step of what was done, and one to show the final result of the experiment. Make as many simple diagrams as you think will be necessary to show clearly all that was done and all that happened. You will find that you can report the usual laboratory exercise by this "moving picture" method with from two to seven diagrams. Label your diagrams. Be sure that your series of labeled diagrams would describe the entire experiment from beginning to end so clearly that a person who had not seen the experiment would know all that was done and all that happened without any further explanation

EXERCISE 5

Jeannette Green November 16, 1928

PROBLEM: Does warm air weigh more or less than cold air?

METHOD: A flask full of cool air was tied in the place of one of the pans of a balance. Weights were added to the other pan until the pointer of the balance remained in the middle. The flask of cool air and the pan with its weights then weighed exactly the same. A bunsen burner was used to heat the flask of air. When the flask was heated it moved upward while the pan of weights moved downward, and the pointer swung over toward the weights.



CONCLUSION: Warm air weighs less than cool air. I think so because the flask of cool air weighed the same as the pan of weights, but the same flask full of warm air weighed less than the pan of weights.

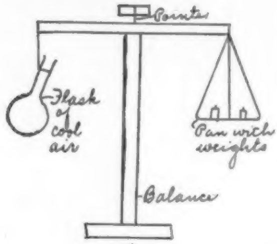
A satisfactory report by the Diagram or "moving picture" method:

EXERCISE 5

Sally Brown November 16, 1928

PROBLEM: Does warm air weigh more or less than cold air?

METHOD:



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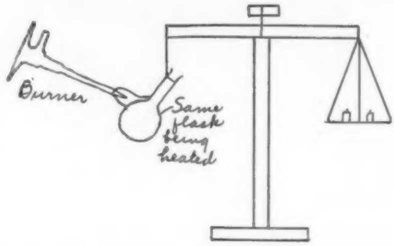

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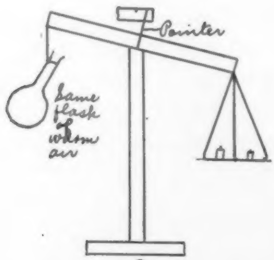

3

CONCLUSIONS: Warm air weighs less than cold air. I think so because after the flask of air was heated, it was too light to balance the pan of weights as it did before it was heated.

It will be noted that the sole difference between the two methods of reporting the exercise lies in step 2, the Method: In the Diagram Method, a series of labeled diagrams showing the progress of the exercise is substituted for the descriptive report of the manipulations and observations and a single diagram in the Conventional Method.

METHOD

This investigation was carried out independently with ninth grade classes in general science in the Owosso, Michigan, high school (designated in the report as School A), and with the eighth grade classes in general science in the Plymouth, Michigan, high school (designated in the report as School B). The same general technique was followed in both schools. In each school an experimental and control group were established and were made "equivalent"[1] by pairing upon two bases: (1) I. Q. as measured by the Terman Group Test of Mental Ability (School A), and the Otis Group Test (School B); and (2) previous knowledge of the subject-matter to be covered by the laboratory exercises included in the investigation, as measured by an objective test. This test consisted of one hundred items of the following types: completion, modified true-false,[2] mul-

tiple response, and modified multiple response.[3] Care was taken in constructing each test that only facts brought out by the laboratory exercises should be covered.

Tables I and II show the degree of equivalence secured by the two bases of pairing:

TABLE I. *The Results of Pairing the Groups on the Basis of I. Q.'s*

	No. of Pupils	Mean I. G.	S. D.	$\frac{M_1 - M_2}{\text{S. D. D. Means}}$ * **
School A				
Conventional Group	19	113.29	±24.35	—.10
Diagram Group	19	114.07	±23.25	
School B				
Conventional Group	21	122.52	±22.1	+.18
Diagram Group	26	121.40	±20.7	

* The groups were considered to be equivalent when the difference of their means divided by the standard deviation of the differences of their means was less than 1.

** The standard deviation of the difference of the means was computed from the following formula:

$$S.\,D.\,D._M = \sqrt{\left(\frac{S.\,D._1}{\sqrt{N_1}}\right)^2 + \left(\frac{S.\,D._2}{\sqrt{N_2}}\right)^2}$$

For convenience this partial formula is here used; the complete formula would tend to increase slightly the results obtained from the partial formula, but not sufficiently to invalidate the equivalence of the groups.

TABLE II. *The Results of Pairing the Groups on the Basis of Scores on the Initial Subject-Matter Test*

	No. of Pupils	Mean Initial Score	S. D.	$\frac{M_1 - M_2}{\text{S. D. D. Means}}$
School A				
Conventional Group	19	26.37	± 9.01	+.84
Diagram Group	19	24.16	± 7.12	
School B				
Conventional Group	21	39.16	± 9.64	+.04
Diagram Group	26	38.80	± 9.60	

3 Francis D. Curtis and Gerald G. Woods. "A Study of a Modified Form of the Multiple Response Test," Journal of Educational Research, XVIII (1928), 211-219.

The investigation was continued for fifteen weeks in each school; two forty-five minute periods per week were devoted to laboratory work in School A, and one period per week in School B. In School A twenty-seven exercises, and in School B twenty-five exercises were demonstrated by the teacher before each group during this period.

The following factors were kept identical in each school for both groups: (1) teacher, (2) laboratory room, (3) laboratory exercises, (4) time spent in the laboratory, (5) initial and final tests, and (6) date upon which each laboratory exercise was performed. A careful check was kept during the period of the investigation to insure that every item of information included in the initial test was subsequently covered by the laboratory exercises for both the Diagram and the Conventional groups.

No textbook was used with either group; the method used was that in which a laboratory demonstration is first written up in the form of a complete report, then supplemented with oral explanations and discussion. Care was taken to insure that, in so as possible, each group received the same preliminary explanations and comments by the teacher, and that the explanations and discussions following the reports of the demonstrations were likewise as nearly as possible identical. During the entire period of the investigation all notebooks were kept in the laboratory, so as to minimize the chances for study and drill upon the materials covered by the laboratory exercises.

Whenever the pupils of either group finished an exercise before the end of the laboratory period, they spent the remainder of that period in reading scientific articles and books; but care was taken that none of this reading material appertained to any of the exercises demonstrated during the investigation. At the end of the fifteen weeks, the initial test of subject-matter was again administered as a final test.

It will be noted in Table III, that such slight advantages as were revealed by the investigation were in favor of the Diagram Method in both schools. These results, however, are not statistically significant, since in both schools the quotient obtained by dividing the difference of the means by the standard deviation of the differences of the means was less than 3.00.

Findings

Table III shows the results of the investigation.

Table III. *Comparison of the Results with Respect to Knowledge of Subject-Matter and to Time Consumed in Teaching the Same Materials by the Two Methods*

	No. of Pupils	Mean Final Score	S. D.	$\frac{M_1 - M_2}{S.D.D._M}$	Mean Percent of time saved by Diagram Method
School A					
Conventional Group ..	19	61.42	±11.70	—.12*	10.9
Diagram Group	19	61.84	± 9.72		
School B					
Conventional Group ..	21	57.20	±14.04	—.95	8.9
Diagram Group	26	60.86	±11.96		

* The same formula was used for determining the significance of the results as for determining the equivalence of the groups. Here, too, for convenience, the partial formula was used; the complete formula would merely tend to increase slightly and thus render somewhat more significant the results obtained.

But while there was no significant advantage of the Diagram Method over the Conventional Method in either school with respect to the learning of subject-matter, it will be noted that there was a saving of respectively 10.9 and 8.9 percent in time for completing the reports of the exercises by the diagram method over that required in reporting the same experiments by the conventional method. In so far as the results of this investigation may be conclusive, therefore, it seems reasonable to conclude that the Diagram Method has a marked advantage over the Conventional Method, since it effects at least as good learning of subject-matter in considerably less time. It seems reasonable to infer, moreover, that if the time thus saved were spent in performing more laboratory exercises or in drill over essentials, the pupils taught by the Diagram Method might reasonably be expected to show, with an equal time expenditure, a knowledge of subject-matter which would be sufficiently greater than that learned by the Conventional Method to be statistically significant. It must be kept in mind, however, that the Conventional Method gives valuable training in written expression, which the Diagram Method does not, and that, therefore, a use of both methods of reporting laboratory exercises would probably offer the pupils better training than the use of either method exclusively.

The Subject-Matter of General Science

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The field of general science is so large that one of the most important problems of text-book authors and course-of-study committees is to determine which topics are important enough to warrant inclusion and which may be safely omitted. A number of curriculum studies have appeared during the past few years which throw much light on this problem. The present paper represents an attempt to combine the results of all these studies with which the writer has come in contact, into a single list of weighted topics.

Fifteen studies were considered in the derivation of this list. These were divided into four groups, according to their method of approach to the problem,—vocabulary studies, interest studies, check-list studies, and text-book analyses.

For each study, the list as presented by its author was divided into three sections,—topics which appeared to be of prime importance (hereafter called 1-topics), topics of value as supplementary or background material (hereafter called 2-topics), and topics of slight importance which could safely be omitted In the consideratioon of each list, the determination of the boundary between 2-topics and omitted topics was necessarily a matter of personal judgment. The same may be said of the determination of the boundary between 1-topics and 2-topics, except that in general the principle that one-fourth to one-half the remaining list should consist of 1-topics was followed. A brief description of the fifteen studies, together with the specific method of determining the boundaries for each list, is given below.

Group I. Vocabulary Studies

Curtis analyzed 630 newspaper articles to determine the science vocabulary and concepts necessary to an intelligent reading of the daily press. His study included the material of the previous Caldwell-Finley study, which was limited to biological terms and concepts. Of the list presented by Curtis, those terms and concepts which appeared with a frequency of ten or greater were retained as 1-topics, those with a frequency of five

to nine as 2-topics, and those with a frequency of four or less were omitted.

Pressey directed a study in which research assistants read high-school text-books in all the sciences, listing all technical terms. Each book was examined by two readers, and new books were read for each subject until the addition of three more failed to increase the number of terms in the list by one per cent. A "common science vocabulary" list was prepared, containing the terms which appeared in all the science lists. All the terms of this list were included as 2-topics.

Group II. Interest Studies

Curtis sent a questionnaire to 3,300 school children and 3,232 adults, each of whom write down the five scientific questions in which he was most interested. Four lists of these interests were presented,—one for boys, one for girls, one for men, and one for women. For each of these lists, those interest appearing with a frequency of ten or greater were retained as 1-topics, those with a frequency of five to nine as 2-topics, and those with a frequency of four or less were omitted.

Pollock sent a questionnaire of the same type as Curtis's to 3,500 eighth-grade children. He presented a single list of interests. Of this list, those interests appearing with a frequency of twenty or more were retained as 1-topics, those with a frequency of five to nineteen as 2-topics, and those with a frequency of four or less were omitted.

Washburne collected about 2,000 science questions from children in school. He also had his normal school students note common facts explainable on scientific principles and experiences involving applications of science. He prepared a list of principles, each of which answered two or more children's questions, explained a number of commonly experienced facts and had some practical applications. This last was prepared on the assumption that biology would be given as a separate subject, so all biological principles were deleted. In the list presented, the frequencies are not given, so all the principles were retained as 2-topics.

Group III. Check-List Studies

Meier sent a list of 75 exercises in general science, prepared from an analysis of text-books and manuals, to 66 teachers of the subject. These teachers checked approximately the third

of the exercises they considered most valuable and the third they considered least valuable. On the basis of these ratings, the 75 exercises were ranked. The 25 highest ranking were retained as 1-topics, the 25 next highest as 2-topics, and the 25 lowest were omitted. The author of this study states that the 75 exercises chosen were intended to be representative of the field rather than all-inclusive.

The writer analyzed the lists of Curtis, Pollock, Webb and Weckel; two standard tests, nine courses of study, and thirty-six text-books and manuals of general science. From these a list of 512 topics was derived, covering practically the entire field. This list was submitted to four groups of judges,—eleven authors of text-books on the teaching of science or of courses of study in general science, six authors of text-books on the junior high school movement and college professors of secondary education, eight eminent scientists, and fifteen junior high school children who had taken general science for two successive years and who were especially selected by their teachers to represent a wide range of general scholastic ability and of aptitude in the subject. These judges marked each of the 512 topics 1, 2 or 3, according as they considered it of prime importance, useful as a background or supplementary material, or unsuitable for inclusion in text-books and courses of study in general science. The children used personal interest as the criterion. The ratings were summed by groups for each topic. for each group(those topics whose average ratings were 1.5 or less were retained as 1-topics, those whose average ratings were from 1.6 to 2.5 were retained as 2-topics, and those whose average ratings were greater than 2.5 were omitted.

GROUP IV. TEXT-BOOK ANALYSES

Webb analyzed the contents of eighteen text-books of general science. Of his list, those topics which appeared in ten or more texts were retained as 1-topics, those which appeared in three to nine as 2-topics, and those which appeared in only one or two were omitted.

Weckel analyzed the contents of fourteen text-books of general science. Of her list, those topics which appeared in eight or more texts were retained as 1-topics, those which appeared in three to seven as 2-topics, and those which appeared in only one or two were omitted.

In judging the final importance of a topic, three criteria were considered,—the number of groups in which it appeared, the number of studies in which it appeared, and its rating in each of these studies. Taking these criteria as a basis, the final list was prepared. This list retains as 1-topics all those which appeared witha 1-rating in three or more studies or in two different groups, or which appeared with a 1-rating in at least one study and appeared in some form in all four groups. It retains as 2-topics all those which appeared as 1-topics in one or more studies, and all those which appeared in some form in three or more studies or in two different groups.

Since the different topics were differently expressed and grouped in the different studies, it was often necessary to exercise judgment in deciding whether a topic expressed in one form in one list was the same thing as one expressed in a different form or implied by a larger or smaller unit in another list. In all cases of doubt in the writer's mind, the rule was followed to assign the higher rating or to consider the topic present by implication. Hence the final list, as here presented, cannot be claimed to be entirely objective in derivation, but will probably be in error principally in containing 1-topics which ought really to be 2-topics and 2-topics which ought really to have been omitted. Since the 1-topics tended to have a somewhat wider distribution among the different studies than did the 2-topics, this list contains a greater proportion of 1-topics than did most of the original lists.

In the preparation of the final list, it was found convenient to group the topics under general subject-headings. This classification is entirely arbitrary, its only function being to assist in locating particular topics. It follows far more closely the classical divisions of the field of science than would any modern text-book or course of study.

The Topics of General Science

MISCELLANEOUS

1—Topics	2—Topics
History of Science	Biographies of famous scientists
Natural resources and conservation	Primitive science
Science of recreation	Natural environment of man
Parks and playgrounds	Social environment of man
Photography and motion pictures	Value of science study
Nature of sound	Laboratory technique
Production and transmission of sound	Science and civilization
	Social institutions and science
	Science of modern industry

Velocity of sound in air, water and solids

Household management
Explosives
Reflection and absorption of sound
Echoes
Acoustics of rooms and halls
Resonance and pitch
Musical instruments
Phonograph
Human voice: operation and care
Ear: operation and care

FIRE AND HEAT

1—Topics
Combustion and fire
Need of air for fire
Products of combustion
Carbon dioxide and water
Smoke
Sources of heat
Common fuels
Gas
Oil
Coal
Fuel supply
Causes of fires
Fire prevention and avoidance
Building and handling of fires
Matches
Fireproof materials
Forest fires
Fire extinguishers
Heating devices and systems
Ventilation
Fresh air
Cooking devices
Fireless cooker
Vacuum bottle
Refrigerator
Manufacture of artificial ice
Nature of heat
Temperature
Thermometers
Fahrenheit and Centigrade scales
Calorie
Transfer of heat
Conduction
Convection
Radiation
Solids, liquids and gases
Freezing and melting
Boiling and condensation
Boiling and freezing points
Evaporation
Expansion from heat
Explosions

2—Topics
Kindling temperature
Spontaneous combustion
Anthracite and bituminous coal
Coke and charcoal
Gasoline
Uses of different fuels
Fire departments
Panic prevention
Humidity and ventilation
Pressure cookers
Ice cream freezing
Cold storage plants
Fahrenheit-Centigrade conversion
Absolute temperature
Specific heat
B. T. U.
Calorimeter
Heat insulation of hot-water pipes
Ice, water and steam
Temperature of boiling water
Temperature of melting ice
Boiling point and pressure
Boiling point and altitude
Evaporation and temperature
Charles' law
Latent heat
Sublimation

LIGHT

1—Topics
Nature of light
Reflection and mirrors

2—Topics
Sources of light: combustion, fluorescence, incandescence

Refraction and lenses
Color and the spectrum
Rainbows
Candles and lamps
Gas lights and gas mantles
Electric lights
Illumination of rooms
The eye and vision
Care and hygiene of the eye

Ether theory
Velocity of light
Straight-line motion of light
Shadows: umbra and penumbra
Diffusion
Twilight
Transparence, translucence and opaqueness
Concave and convex mirrors and lenses: magnification
Images and focus
Telescopes, binoculars and opera glasses
Microscopes
Eye glasses
Prisms and diffraction gratings
Spectroscopes and spectrum analysis
Periscopes and range finders
Slide and opaque projectors
Early lighting devices
Street lighting
Photometer
Eye defects
Optical illusions

FOOD

1—Topics

Sources of food supply
Composition of foods
Proteins
Carbohydrates
Fats
Minerals
Vitamines
Functions and bodily uses of food
Energy or fuel foods
Calorie as a food value unit
Food values of common foods
Regulation of the diet
Balanced diet
Milk as a food
Care and sanitation of milk
Digestion and assimilation of food
Organisms that attack food, and their control.

2—Topics

Tests for food materials
Food economy
Malnutrition
Preparation of foods for use
Cooking
Manufactured foods
Preservation of foods
Food adulteration
Sanitation of the food supply
Food regulations
Production and distribution of milk
Pasteurization of milk
Milk consumption and its encouragement
Other dairy products

CLOTHING

1—Topics

Sources of clothing
Recognition and testing of common cloth fibers
Laundering, cleaning and spot removal

2—Topics

Spinning and weaving
Dyeing and bleaching
Insects that attack cloth, and their control
Cloth adulteration and its detection
Leather and its uses
Functions of clothing
Hygiene and art of dress

WATER

1—Topics

Sources of the water supply: srings, wells, streams, lakes
Plumbing systems
Faucets; replacement of washers
Pumps and air pressure
Sanitation: obtaining a pure water supply
Purification of water: filtration, distillation, aeration, chlorination
Hard water and how it is softened

2—Topics

Distribution of water: dams, reservoirs, aqueducts, pumping stations
Gravity and pressure distribution systems
Fire hydrants
Hot-water heating systems
The syphon
Water closets
Hydraulic ram
Water seeks its own level
Hydraulics and liquid pressure
Hydraulic machines
Fluid motions and streamlining
Density and specific gravity
Displacement and buoyancy
Archimedes' principle
Cohesion and adhesion; wetting of solids by liquids
Capillarity
Surface tension

HOMES AND BUILDING MATERIALS

1—Topics

Glass

2—Topics

Wood
Cement and concrete
Uses of building mterials
Preparation of building materials
Preservation of building materials
Paints and varnishes
Roofing materials
House construction and planning
Building regulations
The home site and its selection
Development of homes from primitive to modern times
Interior decoration

HYGIENE

1—Topics

Care of the body
Rules of health
Community hygiene and sanitation
Health departments and officers
Garbage and sewage disposal
Household pests: destruction of insects and rodents
First aid to sick and injured
Poisons and their antidotes
Safety first
Stimulants and narcotics

2—Topics

Care of infants
Public towels
Air driers
Drinking fountains
Quacks and their avoidance
Sanitary cleaning of rooms
Street cleaning
Hygiene of schools and public buildings

THE HUMAN BODY

1—Topics

Structure of the body; anatomy
Respiratory system and respiration

2—Topics

Skeletal system; bones
Excretory system
Muscular glands

Circulatory system and circulation	Ductless glands
Body heat and its maintenance	Bodily functions; physiology
Growth, development and repair of the human body	Cells and tissues
Sleep	Human body as a machine
	Metabolism
	Organic diseases and disorders
	Physical examinations
	Vital statistics; causes of death

GERMS AND DISEASE

1—Topics	2—Topics
Parasitic bacteria and protozoa and how they grow	Quarantine and segregation
Germ diseases	Favorable and unfavorable conditions for bacterial and protozoan growth
Prevention of disease: prophylaxis	How the body fights disease: work of the white corpuscles
Transmission of disease: infection, contagion, insect carriers	Susceptibility and immunity
Vaccination, inoculation and serums	Animal parasites: tapeworm and hookworm
Common germ diseases	Epidemics
Tuberculosis	Colds and throat diseases
Smallpox	Modern therapy and its methods
Pneumonia	Hospitals, sanitariums and clinics

THE HUMAN MIND

1—Topics	2—Topics
	The field of psychology; general psychology, educational psychology, animal psychology
	The brain and the nervous system
	Reactions and reaction time
	Reflex actions
	Instincts
	Emotions
	Sensations and perception
	Balance and its control
	Memory and thought
	Habits and habit formation
	Mental hygiene and self-control
	Attitudes and ideals
	Personality
	Laws of learning and memory
	How to study effectively

CHEMISTRY

1—Topics	2—Topics
Physical and chemical change	Energy and chemical change
Elements, compounds and mixtures	Metals and non-metals
Molecular theory	Organic and inorganic compounds
Acids, bases and salts	Synthesis and analysis
Neutralization	Solution, ionization and electrolytes
Chemical composition of air	Indicators
Iron and steel	Oxidation and reduction
	Corrosion

Composition of water; electrolysis

Uses of metals
Mining and ore reduction
Alloys
Tempering of steel
Removal of boiler scale
Cleaning of silver
Baking powders and their action
Organic solvents and their uses
Emulsions
Soap and its action
Refining of oil
Coal-tar products and derivatives
Colloids; glue and paste
Fermentation; yeast
Paper
Inks
Oxygen
Hydrogen
Nitrogen
Carbon
Carbon dioxide
Calcium and lime
Mercury
Gold
Radium
Household chemistry

MECHANICS

1—Topics

Potential and kinestic energy
Force, power and work
Horse-power
Inertia and momentum
Mass, weight and gravity
Simple machines lever, screw, pulley, wheel and axle, inclined plane
Power production
Water and wind power
Power transmission
Reading of meters

2—Topics

Uniform and accelerated motion
Translation and rotation
Falling bodies
Action and reaction
Newton's laws of motion
Gravitation and relativity
Center of gravity and equilibrium
Conservation of energy and matter
Resolution of forces
Centrifugal and centripetal forces
Stress and strain
Measuring and weighing
English and metric systems
English-metric conversion
Clocks and watches
Mechanical advantage
Friction and resistance
Efficiency of machines
Perpetual motion and its fallacies
Bearings and lubricants
Machines and their uses
Tools and their value
Machines and modern industry
Household conveniences
Machines and modern farming
Power supply and its limits
Electric power
Water wheels
The turbine
Compressed air and its uses
Soldering and welding
Thermite welding

PROPERTIES OF MATTER

1—Topics

- Physical properties: elasticity, malleability, conductivity, ductility, etc.
- Physical properties of air
- Solution and crystalization
- Physical properties of water
- Evaporation and vapor pressure

2—Topics

- Water as a solvent
- Mutual solubility of liquids
- Kinetic theory
- Boyle's law
- Osmosis and osmotic pressure

ELECTRICITY

1—Topics

- Cells and batteries
- Wet cells
- Dry cells
- Storage cells and batteries
- Magnets and magnetism
- Electro-magnets and their uses
- Electric wiring and the circuit
- Short circuits
- Fuses and their replacement
- Control of electricity; insulation, switches
- Electrical conveniences
- Electric bell
- Radio
- X-rays
- Value and uses of electricity

2—Topics

- Static electricity
- Wimhurst and Toepler-Holtz machines
- Lightning and lightning rods
- Electro-plating and electro-typing
- Nature of electricity: electron theory
- Electrical conductivity and resistance
- Conductors and non-conductors
- Electrical terms and measures: volt, ohm, ampere, watt, kilowatt-hour
- Ohm's law
- Magnetic compass
- Cost of electricity
- Parallel and series connections
- Direct and alternating currents
- Rectifiers
- Electric arc
- Electro-welding: arc and spot methods
- Induction; spark coils and transformers
- Power lines and leakage
- Capacity and inductance; condensers and coils
- Crystal and vacuum-tube radio sets
- Oscillation and wave-length
- Cathode and ultra-violet rays
- Electrical accidents: handling and treatment

TRANSPORTATION

1—Topics

- Steam engine
- Locomotives and trains
- Gasoline motor
- Dirigible balloons and airships
- Airplanes and aviation

2—Topics

- Early modes of travel
- Transportation and civilization
- Construction of roads and streets
- Bridges
- Tunnels and subways
- Submarine tubes
- Railroad construction
- Westinghouse air-brake
- Electric locomotive
- Street cars
- Carts, wagons and bicycles
- Motor-cycle
- Canals and their construction
- Panama Canal

Harbors and harbor improvement
Lighthouses: beacons and fog-horns
Canoes and rowboats
Sailboats and sailing ships
Motorboats
Diesel engine
Steamboats and steamships
Submarine boats
Navigation
Free balloons
Ornithopters, helicopters and gliders
Future of transportation

COMMUNICATION

1—Topics

Telegraph instruments and systems
Telephone instruments and systems

2—Topics

Early communication: speech, writing, signaling
Printing and printing presses
Linotype machine
Printing of pictures
Color printing
Typewriter
Mail and how it is carried
Marine cables
Television
Future of communication

PLANTS

1—Topics

Importance of plants to man
Gardens and gardening
Roots and plant feeding
Nitrogen fixation and the nitrogen-fixing bacteria
Crops and soil exhaustion
Artificial fertilizers and their manufacture
Seeds and their dispersal
Germination
Flowers: structure and function
Pollination
Distribution of pollen
Science of agriculture
Structure and function of leaves
Plant respiration
Transpiration
Photosynthesis
Stems and plant circulatioon
Plant pests and their control
Simple plants: bacteria, yeasts, molds
Recognition of common plants
Trees
Evergreens

2—Topics

Classes and types of plants
Distribution and variety of plants
Artificial plant propagation and improvement
Grafting, budding and tree surgery
Osmosis in plants
Plant adaptations to environment
Conservation of plant life
Forestry; reforestation
Plant diseases
Parasites and saprophytes
Gymnosperms and angiosperms
Algae
Ferns and mosses
Fungi: toadstools, etc.
Grass
Science of botany

ANIMALS

1—Topics

Animal life and its distribution
Insects

2—Topics

Struggle for existence among animals

Fish
Snakes
Birds
Animals (land mammals)

Reproduction among animals
Adaptation of animals to environment
Useful animals; value of animals to man
Diseases of animals and their control
Recognition of North American animals
Survey of animal kingdom
One-celled animals
Sponges and corals
Crabs, lobsters and shrimps
Shellfish
Worms
Spiders
Amphibia; frogs and salamanders
Reptiles
Mammals
Vertebrates and invertebrates
Domestic animals and animal husbandry
Bears
Hibernation
Hair
Predatory animals
Science of entomology

BIOLOGY

1—Topics
Protoplasm and the cell
Cell division and reproduction
Heredity
Interdependence of plants and animals

2—Topics
Living and non-living things
Plants and animals
Metabolism
Parental care
Mendel's laws
Plant and animal breeding: genetics
Selection and variation
Adaptation of species to environment
Biological evolution
Scattering and confinement of species
Adaptability and survival
Migration
Origin and development of the human race
Man's place in nature
Eugenics
Man's control over the environment: euthenics
Balanced aquarium
Balance of life and its disturbance
Life processes: respiration, digestion, circulation, excretion, irritability, reproduction, growth
Reaction and locomotion
Natural history
Eggs
Decay

ASTRONOMY

1—Topics

Earth as a planet; rotation, revolution, size, shape, age
Day and night
Direction: latitude, longitude, poles, equator, zones
Time and the seasons
The moon
Tides
Eclipses
The sun
Solar system
The planets
Mars
Comets
Meteors
The stars; positions, sizes, composition
The constellations

2—Topics

Standard time
The calendar
Sun-spots
The planetoids or asteroids
Double and multiple stars
Celestial distances: light-year, parsec
Nebulae and star clusters
The galaxy or milky way
Astronomical instruments and observatories
Cosmic evolution
Origin of the Earth; planetesimal and nebular hypotheses
The universe
Stellar systems; island universe theory
The sky
Aurora Borealis

GEOLOGY

1—Topics

Minerals and rocks
Fossils
Weathering
Erosion
Sedimentation; deposition, stratification
Rivers and valleys
Earthquakes
Volcanoes
Mountains and their origin
The ocean and its shores
Waves
Seas and lakes
Ground water and its work
Soil and its formation
Classes of soil by texture: clay, silt, loam, sand, gravel
Classes of soil by origin: alluvial, glacial, lacustrine, loess
Soil conservation
Reclamation of deserts: irrigation
Reclamation of swamps: drainage

2—Topics

Composition of the Earth
Interior of the Earth
Crust of the Earth
Geologic eras and pre-historic life
Plains and plateaus
Crustal movements; diastrophism
Surface features of the Earth
Science of surveying
Topographic maps
Glaciers and their work
Icebergs and their origin
Mineral and ore deposits
Mineral resources of the Earth
Natural caves; stalactites and stalagmites

WEATHER AND CLIMATE

1—Topics

The air
Air pressure and its effects
Air pressure and altitude
Winds and their causes
Cyclones and anti-cyclones
Storms
Clouds
Rain
Fog

2—Topics

Absolute and relative humidity
Tornadoes, hurricanes, typhoons and gales
Cloud-bursts
Anemometer
Hygrometer
Rainfall in the United States
"Highs" and "lows"
Isotherms and isobars

Humidity; saturation, dew, dew point, precipitation
Snow; blizzards
Frost
Hail
Thunder storms; lightning
Barometers
Weather thermometers
Rain gauges
Climatic differences and their causes
Climates of the Earth
Climate and life
Weather bureau and weather forecasts
Weather maps
Construction of almanacks

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An Assembly Progam: Galileo's Awakening

Miss M. C. Spalt
Brownell Junior High School, Cleveland, Ohio

Last semester the General Science classes were asked to give a program in the auditorium. The 9A group decided to write their own play. There was only one subject they would consider and that was some phase of the work on the heavens. This was due to the fact that one of the boys was so interested in the subject that he had earned money and bought a six-inch telescope for himself. He had read not only all the books written for children, but many of the technical astronomies as well. Of course his enthusiasm was contagious.

A committee, consisting of two boys and two girls, was chosen. After discussing plans, they divided up the material. Our incipient astronomer wrote, and later acted, all of Galileo's part. One of the girls who could turn anything into rhyme, wrote the poetry—the other two took care of the minor parts.

Two other boys designed a telescope, which was made in our shop. The object lens was of cardboard, 18 inches in diameter, and the whole tube was about 7 feet long. It was mounted on a swivel at the top of a 5½-foot framework. The whole thing was painted with aluminum paint.

The chairman introduced the play with a brief biography of Galileo. Then the auditorium was darkened. A flashlight powder was set off and Galileo appeared in the smoke at the side of the stage. At the same time a slide showing an observatory was thrown on the wall directly behind him. Slides of the various subjects were thrown on four different parts of the auditorium walls (we used two lanterns) and the speakers stood, almost unseen, under the screens. Galileo and the telescope were on the stage.

It proved to be an interesting and instructive twenty-minute program.

Galileo's Awakening

Galileo (appears in cloud of smoke and looks about him). Oh, Providence! you have given me back my eyesight. How good it seems to be able to see the earth and sky once more. I will make much of this opportunity.

Ah! I wonder what strange land this is, and what mountain top I am standing on. It doesn't look like Italy—and what is that queer building with its rounded dome? Why should it be so far away from towns and so near to the sky? There is an inscription on the wall—perhaps it will tell.

(*Goes over and reads aloud*)

LICK OBSERVATORY

As a tribute to James Lick who so generously founded this observatory in 1874, we will close tonight in commemoration of the 55th anniversary of its founding.

Signed

Professor Campbell.

That sign is English. I once studied a little of that language in Italy, before I became interested in astronomy. According to that sign, this must be a building set aside for the study of the heavens, and a fine location it seems to have. How I wish I had had such an opportunity. (*Enters the observatory.*)

Look at that enormous telescope! I remember the first one I made. Small as mine was, it certainly aroused plenty of excitement in the world,—and trouble for me. I remember the first time I looked through it and saw those black spots crossing the face of the sun, and how that almost brought about my imprisonment for disproving Aristotle's theory. I must see the setting sun through this giant. (*Turns telescope toward the setting sun.*)

Sun:

I am the Sun—
And I am needed by everyone.
I'm a million times larger than your earth, and I smile
all the while,
That's right—change your gasp to a smile.
I'm hotter than your hottest fire,
I shine so hot and I never tire.
The planets all revolve around me;
I'm very important, for you see,
I give light to you and most everything;
I'm considered a god for the good I bring.
I help trees to grow and even a weed,
For I am their main support. Indeed,
If it weren't for me, you wouldn't be living,
Because of the heat I am always giving.

Galileo: Why, hot friend, you haven't changed a bit since I saw you last—the same old smiling face, dotted here and there with spots; only you seem larger and clearer. You must have grown considerably since last I saw you.

Sun:

You think I am larger? Oh, my, no!
I think you still do not know
That your telescope makes me seem
Bigger than what you had seen.
Well, ta-ta, old chap, I must go,
For Earth is getting in my way you know.
I'll see you later—if not soon—
For I must reflect some light on old man Moon.

Galileo: Well, well, if it isn't Mercury, just above the place where the sun set. I'll look at him. He never did seem very clear in my telescope. It looked as though he had phases like the moon, but I couldn't be sure.

Mercury:

Mercury is what you call me.
On one side I'm hot as can be,
The other side is cold and numb.
One side is hot and always light,
While on the other it is ever night.
I have no moon, nor even any air,
So of life my small sphere is bare.
I am very close to the sun,
So I can rarely be seen by anyone.

Galileo: Good-bye, Mercury, I am glad to have met you again. Now I'll look at Venus. Her shape almost got me into trouble with the church.

Venus:

I am the twin sister of the earth,
So I shine for all I'm worth.
They say there are possibilities of humans here,
For there must be water on a cloudy sphere.
Like a great lantern I shine in your evening sky,
Watched for by all, a delight to the eye.
But to me, your earth and satellite
Show their faces full and thus still more bright.

Galileo: Farewell. Now that I have verified what I saw in my small telescope, I'll look at Mars just peeping over the hills there. He was always a mystery to me.

Mars:

My name is Mars, after the god of war.
I know you've heard of me before.
My diameter is only half that of the world,
Many of my mysteries to you are not unfurled.
Have I humans? Well, I guess
It's not for me to answer yes.
My color is red—a beautiful hue,
And I'm sure it is attractive to you.
I have two small moons named Fear and Flight,
And they shine for me every night.
But say, do you see that planetoid?
She is one you should not avoid.

Galileo: What is this—a new planet?

Planetoid: I'm a planet all right, but they don't call me that, even though I do revolve about the sun like all the rest of my big brothers and sisters.

Galileo: What do they call you?

Planetoid: It's rather peculiar. Because I'm so much smaller than the planets they give me a bigger name. They call me a planetoid. I'm one of about eight hundred in the solar system.

Galileo: Fare-thee-well, stranger! You are something new to me all right. Now I think I'll look at my attractive friend just rising over there. I know him best of all, for when I first turned my small telescope on him I saw tiny stars close by. I watched those stars for several nights and finally discovered they were his satellites. I wonder if Jupiter still knows me?

Jupiter:

I am larger than all the rest,
I have nine moons, so I am the best.
Of my moons you saw only four—
I don't think you've heard this before,
There are five more which you didn't know
Because they were too small to show.
Many cloud belts encircle me,
These serve as distinguishing marks you see.

Perhaps to you I'd not seem so bright
But I shine by my own, as well as reflected light.

Galileo: So you have nine children, friend Jupiter; you ought to be proud of them. Besides proving that Ptolemy's theory was wrong, they helped the world discover the speed of light. Now I think I'll look at Saturn. I never did like him. He always looked so blurred and bumpy in my telescope. I wonder what he really does look like.

Saturn:

I have ten satellites or moons;
And I am Saturn whom
You see when the sky is clear.
If an ocean were found in which I could float,
My weight is so small, I'd sail like a boat,
I have rings about me--they are three;
You wondered what they could be.
They are numerous tiny moonlets near,
Formed like rings about my flattened sphere.
Now turn your telescope further yet;
There are two more planets you must not forget.

Galileo: No wonder I couldn't solve your riddle, Saturn. This telescope certainly does make those rings stand out, and you certainly are a thing of beauty, now that I can see you clearly. But, great stars! do you mean to say that there are two more planets? I'll turn my telescope on that tiny point of light you told me to. I can't thank you enough for telling me.

Uranus:

Your telescope wasn't strong enough
To show Uranus strutting his stuff.
Herschel, about seventeen eighty-two
Made a discovery very true.
What you thought only a star,
Was really a planet, shining afar.
Father Sun is a long, long way from me,
So I'm cold, and dim, and hard to see.
There's one more planet you didn't find;
Look very close—he's not far behind.

Galileo: Yes, now I can see your disk, and you surely are a member of the sun's family. I'll look for the other planet, if you say so. I can't find anything. Oh, there it is. It doesn't seem very clear.

Neptune:

I am Neptune, far away from you,
I am one you didn't discover, too.
Two men with pencil and paper discovered me.
One night each was as anxious as could be,
For Uranus was off the track—
They must find a way to put him back.
They worked, and worked, to make me appear;
They knew I couldn't be very near.
But they strove until they located me.
So here I am, waiting for you to see.

Galileo. I'm glad to hear that other men have carried on my work. How ignorant people used to be about our great solar system.

Just to rest myself a bit, I'll look at a few constellations with the naked eye. Yes, over there in the north, the Big and Little Bears are still traveling around the North Star.

The Big Bear: I am the Big Bear—the best known of the constellations in the northern skies. According to the Greek legend, I was once a very beautiful woman living on earth with my father, king of Arcadia. I was a rival of Juno, the queen of the heavens. She, being very jealous of me, complained to Jupiter, and he, to protect me from her anger, changed me into a white bear. I lived in the woods a long time, dodging the many hunters who sought to kill me. One day my son Arcas set out to hunt, and met me on one of the woodland paths. I was so overjoyed at seeing him that I ran toward him. But, of course, he did not recognize me, and lifted his bow to shoot. Just then Jupiter came along and saved us both by changing him into a bear too. Then he swung us both by the tails up into the sky That is why we two bears have so much longer tails than the bears on earth. If you look up into the sky any clear night, you will find us swinging around the North Star, which is really the last star in the tail of the Little Bear. You probably know us better as the two Dippers. Each of us is composed of seven stars, three in the handle and four in the bowl. The two outside stars of my bowl point toward the North Star, so that sailors always look for me.

Galileo: They haven't changed a bit. Now I'll look at the most brilliant of all the constellations, Orion and his dog.

Orion: I am Orion, another well-known constellation. Ac-

cording to a Greek legend, I was the son of Neptune and a famous Amazonian huntress. I became the most famous hunter in the world, and boasted there was no animal on earth that I could not overcome. To punish me for my pride, a scorpion sprang out of the earth and stung me in the foot, causing my death. Upon the request of Diana, goddess of the moon, I was placed in the heavens. If you will look for me any bright winter's night in the southern sky, you will surely find me. Do you see the four bright stars that form a rectangle around me? Two of us are of the first magnitude. Then there are three stars which form my belt, and three still smaller ones which form the sword. I also contain a great gaseous nebula which has puzzled astronomers for a long time.

Orion's Dog: I was one of Orion's hunting dogs, and was placed in the sky with him. My brightest star is Sirius, the most brilliant of all stars seen on earth. You seem to be getting rather hazy, for one of those pesky comets is coming between us.

Galileo: Thanks for telling me about that comet streaming across the sky. I want a good look at him through this giant telescope.

Comet: Hello, folks! I really haven't much time to talk with you. I'm in a big hurry.

Galileo: Where are you going?

Comet: Oh, around the sun. I'm one of hundreds who travel in narrow, oval-shaped orbits, and I'm gathering speed now, for I'm getting nearer the sun. Some of the planets better move off my orbit. I come pretty close to some of them. The Earth has at times actually passed through my tail. That's because my tail is several million miles long and is only gas, illuminated by the reflection of the sun. I myself am only burning gases, and not a mass of solids. Good-bye. I'm off now.

Galileo: I always thought you fellows were light and gaseous. But in my time people thought your appearance meant bad omens and tidings of death. Oh, look! There goes a meteor.

Meteor: I'm in even more of a hurry than the comet. Your atmosphere, as I rush through it, makes me burn up in so short a time that I hardly ever reach the ground. I think I'll reach

my goal this time. Look out! Here I come! (*Bang, off stage, as meteor strikes.*)

Galileo: There was so little left of him that he did no harm. Just a lot of noise as he shattered himself on that rock yonder. Before I go I must see the moon. Oh, how close! How irregular! Look at those craters and mountains.

Moon:

When night comes I take the place of the sun,
And I am loved by everyone.
I have no light of my own,
That, of course, is surely known.
The light of the sun reflects on me,
And I'm as cold and dead as can be.
I'm not so large and not so small
But I can be seen by one and all.
I have hills, mountains and rough spots,
They seem to you like great big dots;
I have no water, nor even air,
So I think some folks don't play fair
When they talk of a man in the moon,
Who always sits here humming a tune.
Maybe they say this just to tease,
But really, I love my position, I think it's fine,
And you'll agree when I say it's sublime.

Galileo: I'm glad I have discovered my mistake in calling those large plains on you seas. Good-bye.

Oh, friends, how little I knew of you before I came here. Besides becoming acquainted with two new planets and the way they were discovered, I've learned about planetoids and comets. How far man has progressed! What a wonderful universe we live in. To think of man using his ability to create this great telescope which has unfolded so many sublime mysteries! But dawn comes, so farewell, oh universe!

Form of Outline for Science Units in a Teacher's Manual—Elementary Science or Nature Study

W. G. Whitman, State Normal School, Salem, Mass.

A state committee is preparing an outline in elementary science for the use of teachers in all the grades. The form this outline should take, the kind and amount of material it ought to include, have raised many perplexing questions. Following the introductory matter, which will include general objectives, we plan to organize the material as separate units and give each details as are suggested in the two sample units which follow. Approximately twenty units have been suggested for each grade. The committee will be very glad to receive suggestions and criticisms from those who read this.

Elementary Science—Grade 1—Autumn

UNIT 6. BULBS

Objective

To teach a simple method of bulb culture and to have bulbs blooming in the room during the early winter.

Pupil Problem

How can I get flowers for the Christmas table?

Story of the Unit

Paper white narcissi are easily grown in bowls of pebbles filled with water. Be sure the bulb is set deeply enough to stand upright when in bloom. While not necessary to put these in a cool dark place, as with most forced bulbs, the plants will usually be stockier if treated in that way for a week or ten days. Select firm, solid bulbs. For contrast in time and type of development let some remain in the schoolroom from the first and put others in the dark. Plan time of planting and care so that children who wish may have flowers to take home for Christmas Day. Let the children make bowls for the bulbs as a lesson in handwork or art. If feasible, go to the shore and gather white or prettily colored stones in which to set the bulbs.

Teaching Aids and References

Materials: Bulbs, pebbles, paper white narcissus bulbs.

Meier, School and Home Gardens, Chapter 2, Ginn and Company.

Procedure

Discussion

How many bulbs shall we put in one bowl? How deep must the bowl be? Why is it better to set the bulb down amongst the stones rather than on top of them?

Activities

(Bowls must be made and stones gathered previously, if done at all.) Let the children work in small groups and do the planting. Have enough bowls to permit of one for each table or in several parts of the room if there are desks for the children. Children care for them until blossom has faded. Pupils who will take their flowers home will perhaps bring bowls from home and may be asked to supply bulbs.

Supplementary Questions

Where does the plant get its food?

Why can this plant blossom indoors when those in the garden are all asleep?

ELEMENTARY SCIENCE—GRADE 1—SPRING

UNIT 2—THE SUN

Objective

To teach what the sun does for us—Change of day and night and the seasons—leading to the general concept that the sun is essential to life on the earth.

Pupil Problem

Why does not the sun shine all of the time?

Story of the Unit

The sun is of more importance to us than any other body except the earth itself. Without heat from the sun the earth would become a cold body without any life. Without light from the sun we would be in perpetual darkness except for our artificial lights. Because of the whirling motion of the earth about half the time we face the sun—that is daytime—and the other half of the time we face away from the sun—that is night. Because of the changes in the position of the earth we have the seasons. Autumn, when the days are growing shorter; winter, with its cold weather, as a result of short days and diminished heat from the sun; spring, with the lengthening days; and summer with its long days and strong heat. The sun's heat in spring melts ice and snow, starts the plants into action and urges the birds to move northward. The cooling of fall checks the growths of plants and makes them dormant. The light of the sun can be separated into the beautiful rainbow colors by means of a glass prism.

Teaching Aids and References

Materials needed: Pictures of the sun and glass prism.

Chant, Our Wonderful Universe, Chapter 4, World Book Co.

Procedure

Discussion

Bring out by class discussion the knowledge and experience the children have relative to the sun.

1. What is the most important object in the sky?
2. What does the sun give us? (Light and heat.)
3. Where does the morning sun shine? The afternoon sun? Why this difference?
4. Where is the sun at night?
5. The sun makes the day; what makes the night?
6. What change does the sun make about us?
7. What effects have you observed on plants? On animals?

Activities

1. Have child face a window or a lighted lamp, and turn around. The window or lamp represents the sun, and the child the earth. Lead him to explain day and night. (Explanation of seasons is too difficult for this grade. Be satisfied with the facts of seasonal change.)
2. Throw solar spectrum on white wall by turning glass prism in a beam of sunlight.

Supplementary questions

1. How does the length of day affect our actions or activities?
2. How does the season affect plants? animals?
3. Where do the sunset colors come from?
4. Where do rainbow colors come from?

A Method of Diagnosis and Remedial Treatment in General Science

Ralph C. Bedell
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With the increase in emphasis being placed on the mastery of major science conceptions, rather than mere acquisition of encyclopedic information, there is an imperative demand for some workable method of diagnosis and remedial treatment for pupils who have difficulty in the mastery and use of science ideas. Especially is this true in the larger schools where demands for economy are resulting in larger classes. The following is a brief outline of the method by which Southwest High School is attempting to solve the problems of diagnosis and remedial treatment.

The general science course which is being offered in Southwest High School is divided into fifteen units, each unit being subdivided into problems. Each unit has as its objective some major science conception, the problems bringing out the necessary ideas to make the objective of the unit understandable to the child. It is important for both teacher and pupil to know which of these ideas the pupil has mastered. We have attempted to devise a series of tests which will make this diagnosis for each unit.

In making the test for a unit, the main ideas in each problem are determined, each idea serving as the basis for a test question. The questions are grouped in such a way that by noting a pupil's errors on the test, the problem or problems in which he is weak can be determined. An attempt is made to test the understanding of the ideas rather than the mere recall of facts.

The test form used is that of Pieper and Beauchamp in their "Major Idea Test." Each test item consists of an incomplete statement followed by four clauses, phrases, or words which may or may not correctly complete the sentence. If the pupil judges the completion true, he indicates by a plus sign; if he judges the completion false, he indicates by a minus sign. All four judgments must be made correctly for the pupil to receive credit for the knowledge of the idea in the test item.

The following is an illustration of a test item which is correctly marked:

A reputable physician
(a) often advertises in newspapers and magazines........(—)
(b) gains his reputation by his service to mankind.......(+)
(c) prescribes only patent medicines.....................(—)
(d) prescribes only extensively advertised remedies......(—)

Any form of objective test might prove quite as satisfactory as the above.

The test questions are mimeographed and given to the classes immediately following the study of the unit for which the test is devised. If two equal forms were available, the tests could be given immediately preceding the unit and the results used as a basis for the class instruction. The test at the end of the unit would then serve as a measure of the pupil's growth, as well as furnish a second diagnosis.

The results are used as a measure of accomplishment and for diagnosis.

AS A MEASURE OF ACCOMPLISHMENT. After the tests are scored a frequency distribution table is made from which quantiles and medians are determined.

The grading system used in Kansas City is roughly the same as that used in many high schools and colleges. The grades being E—excellent, S—superior, M—medium, I—inferior, F—failure. In a non-selected group there will be approximately 50% of the class receive M, about 25% E and S, and about 25% I and F.

To receive a grade of E, a pupil must have a score on the test which is distinctly above that of any of the others. Ordinarily the S group will be determined at about the upper quartile and the I group at about the lower quartile. To receive a grade of failure a pupil must receive a grade which is distinctly below the remainder of the group. The method of determining grades must necessarily depend partly on the teacher's judgment, but not to such a great extent as in other methods often used.

This method of grading seems to appeal to the students as being quite fair. They seem to appreciate the fact that no student's personality is directly considered in determining his grade. For when the grades are determined the score of any individual student is not necessarily known.

Other factors are necessarily considered in making the pupil's final grade for the unit. These are: (1) the quality of the report given by the pupil at the end of the unit; (2) the quality of the work and the efficiency of the pupil in solving exercises of the unit; (3) the number and quality of voluntary contributions made to the class (these do not include talks and reports which are voluntary, but include voluntary demonstrations, projects, and the like); (4) the contribution of the pupil to the class discussion and to the general progress of the class and its work.

TO DIAGNOSE DIFFICULTIES OF PUPILS. The tests are rescored to determine the percent of correct answers to each of the questions.

If any one question or group of questions shows an unusually low percent of correct responses, the questions are investigated to see if the wording, arrangement, or content is such that they could not be easily understood. If no fault is found with the question, the class is reviewed over that portion of the unit which the test results indicate has not been mastered. In some cases this review is formal, but in most cases it is incidental. In many cases it is accomplished by asking some pupil to make a talk on the text material which is to be reviewed. If a pupil who is intensely interested in the material makes the talk, the results seem to be better.

The frequency distribution table, with grades marked, is put on the board the day following the test. Each pupil, knowing his own score, can determine his grade. The teacher then asks each pupil to decide if he considers the grade on the test a fair mark of the best he can do on the unit. If the pupil judges that the grade is the best he can do, no individual diagnosis is attempted.[1] If the pupil judges that he can do better than his test grade indicates, he is given the opportunity to consult with the teacher after class hours.

All case studies are taken from Unit VIII, The Nature and Control of Fire. In each case, the interval between testings was eight days. The highest possible score on this test was 18.

1. S. B. Boy. Age 14 years 2 months. First semester grade M. Ranked in the middle 50% on the National Intelli-

1 The large numbers taught make it impossible to give an individual diagnosis to each pupil. Classes average approximately 37.

gence Test. Generally rated by his teachers as an average pupil. An unusually conscientious boy who always seemed to try his very best. A good, willing worker. However, general science seemed to be difficult for him to master sufficiently to apply a major idea or conception to some illustration which had not been studied or discussed in class. Score on his first test was 4, a failure. A study of his test paper showed he had correct answers for questions 5, 12, 13 and 14. A short talk with him disclosed that he had a very meager knowledge of the method of regulating a burning fire, which is the major idea of question 5. S. B. showed good knowledge of how we obtain our fuels and their relative importance, which are the ideas in questions 12, 13 and 14. S. B. was given the following directions: "Review and study carefully all of Unit VIII except Problem 5 (which is the problem on fuels). Answer all exercises in the text, except those in problem 5, and bring written answers to the teacher." S. B. brought all the exercises correctly answered and was allowed to retake the test. Score on second test 11, a grade of M.

2. J. F. L. Girl. Age 14 years 4 months. First semester grade M. Rated in the upper part of the lower 25% on the National Intelligence Test. J. F. L. was one of the small group who consistently came back for help. She never displayed more than ordinary ability, but did work very conscientiously and earnestly tried to do her best. Her continued willingness to keep trying seemed to be equalled only by her patience to repeat a problem or exercise until she was sure she had done her best. Her first test showed a total score of 7, an I. She came in for help the afternoon of the day the test was given. An analysis of her test showed that she had correctly answered every question on problems 1 and 2, but that she had missed questions on the remainder of the Unit. She had failed to master the following ideas:

1. What a flame is.
2. What happens to materials when they burn.
3. How can destructive fires be prevented.
4. Why wood is an important fuel.
5. Why coal has largely replaced wood as a fuel.
6. How a carbon-dioxide fire extinguisher works.
7. How small fires are extinguished.

She was asked to do the following exercises:

1. Read and outline story of Unit VIII.
2. What part of a candle flame is the hottest
3. What happens to a candle when it burns?
4. (a) Why is wood an important fuel?
   (b) Why has coal replaced wood as a fuel to the extent it has?
   (c) Of what is coal composed?
5. List as many methods as you can which tell how destructive fires may be prevented.
6. How does a carbon-dioxide fire extinguisher work?
7. How may small fires be extinguished?

Correct written answers were brought for every exercise and J. F. L. was allowed to take the test a second time. Score on second test 13, a grade of M, almost double her original score. As this seemed to be about the limit of her ability, she was not encouraged to work any more on Unit VIII, but to concentrate her efforts on the class work being done at the time.

3. O. G. Boy. Age 13 years 7 months. Grade first semester S. Rated in the upper 25% on the Terman Intelligence test. O. G. did well in his general science, as well as in the rest of his school work. No teacher seemed to think he did a great amount of work, but each was certain he did all his assigned tasks well. He seemed to be quite fascinated with general science, so much so in fact that it was occasionally difficult to hold him to the exact material being studied at any one time. Score on first test 10, an M. An analysis of his test disclosed that he did not understand the following:

1. The characteristics a material must posses to be classed as a fuel.
2. How oxygen is prepared from red rust of mercury.
3. The hottest part of a gas flame.
4. The fact that coal is principally fixed carbon.
5. Some methods of preventing destructive fires.

O. G. was given the following exercises:

1. What characteristics must a substance possess to be classed as a fuel?
2. Give two ways to prepare oxygen.
3. What part of a candle flame is hottest?
4. What is the composition of coal?
5. How can destructive fires be prevented?

As soon as his answers were handed in he was allowed to repeat the test. Score on second testing was 14, an S. While this was an increase of only 4 points, it is one-half of the total increase he could have made.

4. C. B. Boy. Age 14 years 3 months. Grade first semester M. Rated in the middle 50% on the National Intelli-

gence test. C. B. always seemed to try his best at his work, especially in general science, which seemed to interest him very much. Score on his first test 14, a grade of S. An analysis of his test showed that he did not understand the following:

1. All points of a flame are met at the same temperature.
2. A candle flame gives off water vapor.
3. Coal is principally fixed carbon.
4. The source of petroleum.
5. That petroleum must be refined to get the products which we use.

When asked why he missed these points, C. B. very readily confessed that problems 1 and 5 were the only ones he had not studied. The following exercises were given:

1. What is the hottest point of a flame?
2. Of what is coal composed?
3. (a) How do we get petroleum?
   (b) How do we get the various useful products from petroleum?

G. B. was not asked to work an exercise on the fact that a candle flame gives off water vapor, because he assured the teacher he knew that but had missed it on his test because he did not read the test question carefully. The score on his retest was 17, making an increase of three out of a possible four points. The only idea missed on the retrial was on the fact that water vapor is given off by a candle flame. Evidently the idea had never been learned.

5. W. D. Boy. Age 15 years 1 month. Grade first semester M. Rated in the lower part of the middle 50% on the National Intelligence test. W. D. seemed to have difficulty in mastering his general science material, but he always showed a keen interest in the subject. His other teachers generally rated him as an I or F pupil. Score on his first test 9, an M. An analysis of his test showed he had not mastered the following major conceptions of the Unit:

1. Fire may be used to supply light.
2. The characteristics a substance must possess to be classed as a fuel.
3. (a) The air is about 20% oxygen.
   (b) Lavoisier discovered that oxygen is the gas which supports burning.
4. Burning does not destroy matter, it merely changes its form.
5. Some of the common products of crude oil and how they are obtained.
6. How a carbon-dioxide fire extinguisher works?

He was given the following exercises:

1. How does man make use of fire?
2. What characteristics must a substance possess to be classed as a fuel?
3. Who discovered oxygen to be the fire gas?
4. What percent of the air is oxygen?
5. Outline the paragraph on crude oil.
6. How is a carbon-dioxide fire extinguisher made?

His retest showed a score of 13, an M plus. Every question which he had answered correctly on the first test was correctly answered on the second. That is, the additional five questions he had answered on the second test had been missed on the first test.

It may very justly be asked what percentage of gain on a retest is due to remembering the test material rather than a mastery of the major ideas of the Unit. The interval between tests is made at least a week for the specific purpose of preventing such memory, no pupil being allowed to see a test during the time interval.

This being the first time Southwest High School has attempted a direct diagnosis and remedial treatment, there are many improvements and refinements to be made. The above represents the progress we have been able to make during the school year 1928-29.

A Modern Miracle—Paper Making[1]

No longer does anyone wonder at the discoveries and processes by which life is made more livable and interesting. Wood is transformed into paper, and it is taken as a matter of course. A piece of paper with the proper signatures and printing may become financial protection against a future property loss. Truly, these are two marvels that deserve a moment of pause for appreciation.

The ancient Chinese are recorded in history as far in advance of the rest of the world in the matter of science and mechanical inventions. In the year 105 A. D. the Emperor of China requested one Ts'ai Lun to undertake to discover how to manufacture a writing material. After considerable research Ts'ai Lun found that by reducing the inner bark of the mulberry tree to a pulp, treating the pulp by beating it

1 Reprinted from "Safeguarding America Against Fire," by courtesy of National Board of Fire Underwriters.

and matting the resulting fibers in sheet form, a suitable writing material could be made. His detailed report of the results of his experiments are generally accepted as a description of the process of making the first paper. In later investigations Ts'ai Lun found that rags were even more suitable for paper manufacture than the inner bark of the mulberry tree.

It is always interesting to trace an industry to the earliest record of its existence. The origin of the insurance idea, like paper, can be traced back to the dawn of history. While King Hammurabi of Babylonia was still inscribing messages on clay tablets and other crude forms of writing material, he devised a system of financial payment to assist his subjects who suffered losses from fire. Paper-making and insurance have been associated for hundreds of years, each depending on the other to a considerable extent. The paper industry employs the product of insurance (financial protection) and the insurance companies use vast stores of paper annually to keep complete records and files.

The first historical record of paper-making outside of China, comes from the eighth century, when two Chinese paper manufacturers were captured by Arabs in Turkestan, taken to Damascus and given the task of building a paper mill. From there the industry spread to Spain in the same century, during the invasion and occupation of Spain by the Moors. A paper mill was established in that country in 1150, in France in 1189, in Germany in 1320 and in England in 1494. The sixteenth century saw the establishment of the industry in Scandinavia, while the first paper mill was built in the United States by Walter Rittenhouse in 1690.

Throughout this long development of the paper industry rags continued to be the chief raw material. They were always difficult to obtain in large quantities and were expensive, thus handicapping the manufacturers' efforts to produce large quantities of paper at a low price. After the invention and improvement of printing processes the demand for paper increased tremendously, which stimulated research for other materials suitable for paper manufacture. Various fibrous materials were investigated but nothing proved entirely acceptable until the wood pulping processes were discovered.

Processes and materials similar to that employed in making the first sheet of paper in China at the opening of the Chris-

tian Era, are still used in modern paper-making. Today the manufacture of paper begins in the forests, when pulpwood is cut. Brought to the mill, the wood is converted into a pulp composed of small fibers; after a series of treatments to render them more suitable, the fibers are matted into sheets of paper. These, in a broad way, are the general processes of paper manufacture. They differ from those used in making the first sheet of paper, in that the whole tree is now used instead of only the inner bark, and a laborious hand equipment is replaced by power-driven machines of great capacity and speed. Few industries have changed their general processes so slightly since their origin; but few industries have applied modern methods and equipment to such a remarkable extent.

Insurance was early recognized as an important ally that would foster growth by safeguarding material and property values. Financial protection was secured for almost every phase of the manufacture of paper from the beginning to the finished product. As in all great industries, development would have been retarded immeasurably without the cooperation of sound stock insurance, for capitalists could not have been induced to invest to any great extent unless assured that their money was safeguarded from sudden loss.

The Miracle of Paper from Wood

When the industry was first started, spruce was by far the most suitable wood, with the result that plants were centralized in the Northeast and Lake States, where trees of this type were most plentiful. However, as technical development was made the tendency was to include all types of timber, the industry constantly favoring the extended use of other species, until today almost any forest is a potential source of pulpwood.

One usually thinks of pulpwood as coming from small trees; in fact, the pulp and paper industry does use successfully much smaller timber than can be employed for the manufacture of lumber and other high-grade products. In the older producing regions the pulpwood forests were usually composed of small trees, but in the newer regions of the South and the Pacific Northwest they do not differ greatly from other types. Spruce and balsam fir are preferred in the Northeast; in the Lake States, spruce, balsam fir and hemlock; in the South, pine; in the West, Sitka spruce and western hemlock. Accessibility

to existing means of transportation, rail or water, is an important requirement and the forest area must be sufficient to furnish a relatively large annual cut in timber.

With timber resources in the United States valued at $10,000,000,000, the paper industry, dependent upon the production of pulpwood, is vitally interested in protecting its forests from fire. As the interested agencies learn more about methods, and realize the seriousness of losses, fire protection for forests is made more adequate throughout the United States. The greatest progress has been experienced in the Northeast, but concentrated effort in the Pacific Coast States is approaching adequacy. In the South only a meager beginning has been made, but pressure for protection is being felt.

"Making pulpwood" is the term generally applied throughout the Northeast to cutting the trees and preparing them for transportation to the pulp mill. The pulpwood is usually cut during the winter, gangs of men being stationed at camps conveniently located throughout the forest. The men usually work in teams of two in small areas which are definitely allotted to each team. They chop down the trees, clear them of branches, and cut the trunks into convenient lengths for handling. During the winter the wood in the forest is collected by heavy tractors and trains of sleds, and the pulpwood "bolts," or logs, as the case may be, are hauled to railroad sidings or to drivable rivers. In former days horses and sleds were used for this purpose, and they are still used to some extent today.

When the pulpwood is taken from the forest to the mill by rail, the bolts, or logs, are simply piled on stake cars for transportation. This method is most common in the South, in the Lake States and in the Northwest. When received at the mill, rail-shipped wood is usually stored in tremendous piles. The wood-yard is a network of railroad sidings, along which the wood is stored, making it an important subject of insurance since values at some places run as high as a million dollars. To facilitate handling, pulpwood is sometimes stored near the grinding mill, but good practise necessitates a clearance of at least 100 feet from buildings of importance or even more if piles are high. Large yards, which are well-administered, have flood lights and search lamps, as well as good watchman service. Often fire protection is provided by hydrants, and we find monitor nozzles on high platforms close to the piles,

the nozzles swinging on a fixed pivot. Logs are wet down frequently during dry weather. As it is difficult to check a fire that is well under way, the importance of these protective and preventive measures is obvious.

In the Northeast and Canada much of the pulpwood is river-driven to the mill. Large quantities are concentrated at convenient places along the river banks, put into the river during the flood period in the spring and carried down stream by the current to the mill. Gangs of men follow to prevent log jams. In this way large quantities of wood can be transported relatively long distances at low cost. Arriving at the mill, wood is usually held in the water by booms, which are simply logs fastened end to end to fence in a large area. The wood is taken from the water directly to the pulp mill as it is needed. Meanwhile, if the boom breaks, large quantities of logs float down stream and it is a very expensive proposition to recover them.

Before wood may be pulped it must be cut to convenient size, usually two-foot lengths; the pieces of larger diameter must be split and the bark removed. Frequently the bark is removed in the woods during the spring, when peeling is possible, but most wood arrives at the mill in a rough state. There are a number of machines for barking, among which the drum barker is most common. The rough wood is conveyed into one end of the machine, which revolves continuously; by friction of the pieces of wood against each other and against the roughened sides of the machine, the bark is removed and the cleaned sticks are automatically ejected.

PULPING PROCESSES

The first experimentation in the pulping of wood is recorded in England, where efforts were made to cook wood in a soda solution similar to that used to pulp rags. No marked success followed this experiment. In 1840 Keller, working in Germany, discovered that wood could be reduced to a pulp by grinding it, this being the forerunner of the modern mechanical process of pulping wood. Some twenty-five years later, Thighlman, an American, discovered that sulphurous acid removed from wood the ligneous elements, leaving a residue of practically pure cellulose. Thighlman's pioneer work was

taken up by various experimenters in Europe and led eventually to the perfection of the sulphite process.

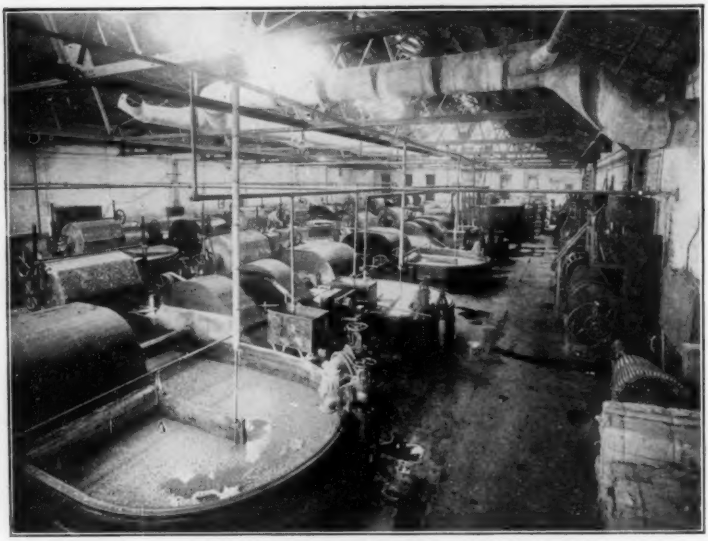
Early experiments in cooking wood in a soda solution were later worked out in greater detail to form the basis of the modern soda process. The sulphate process was discovered in Danzig about 1884. It was not generally used, however, until several years later, being introduced into North America

THE GRINDING ROOM

about 1908. Discovery of the wood-pulping processes did not immediately relieve the pressure for greater paper production in the United States, and the use of rags and other materials continued. A greatly augmented demand for newspaper during and immediately following the Civil War led to an extensive use of straw paper, and wrapping paper made from straw was common throughout the country. By 1880, however, the wood-pulping processes were sufficiently developed and freed from patent litigation to permit of extensive use. Mills were

built throughout the Northeast, where the supply of spruce was greatest, and later in the Lake States.

After removal of the bark wood destined for mechanical pulp is ready to go directly to grinder. For chemical pulp, however, each block of wood must be chipped into small pieces about three-eights of an inch thick and three-fourths of an inch long. These chips are made by passing the wood through a series of knives, which hack off pieces across the grain. They are then screened to remove sawdust and uneven pieces before being transported to the chemical digester.



TREATING PULP

There are four commonly used pulping processes, of which the simplest and cheapest is mechanical, known as the groundwood process. Mechanical pulp is made by forcing a stick of wood against a revolving grindstone, which defibers the wood by abrasion; there is no chemical change in the form of the wood. This pulp is used in relatively cheap papers where a high grade of permanency is not necessary, such as in newspaper and the cheaper forms of wrapping paper.

In the chemical processes the ligneous elements in the wood

are dissolved, leaving a residue of cellulose. Wood chips are cooked in a large digester four to twelve hours, depending upon the kind of wood and the character of pulp desired, then the digester is "blown" and the pulp washed and prepared for subsequent manufacturing processes.

Pulp is usually subjected to treatments to make the fibers more pliable; they are then isolated in an excess of water and separated from all foreign materials. In beating, the most common of these processes, the pulp passes many times between revolving knives and a bed plate that effects a brushing action upon the fibers, making them more pliable and creating a surface capable of greater cohesion. In the beater, colors and loading materials are added for special kinds of paper, but for high grades, where whiteness is desired, such as book and writing papers, the pulp is usually bleached before beating takes place. Various other treatments are used in the manufacture of paper of special requirements.

The Paper Machine

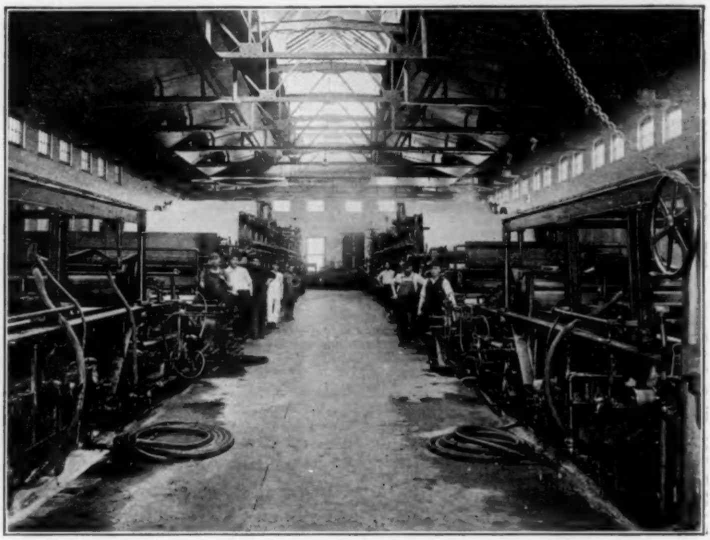
Before reaching the paper machine the pulp formula or "furnish" is mixed. Few papers are made entirely of one pulp; most of them require mixtures in varying proportions, which are prepared in a mixer and in an excess of water. From the mixer the pulp passes through screens, thence to the paper machine, a tremendous mechanism constructed for continuous operation. It accomplishes three purposes: it forms the sheet, sets the fibers in the sheet, and removes the water.

At most mills one finds the Fourdrinier paper machine, consisting of an endless wire screen upon which the paper sheet is formed and where a large part of the excess water is removed. From this screen the pulp film passes through a series of press rolls to set the fibers and then to another series where the remaining excess moisture is removed. These operations are continuous, the pulp in slush form coming in at one end of the machine and the paper, in a long endless sheet, being removed from the other.

Certain varieties of paper require other types of machines. In the cylinder type, large cylinders of wire mesh similar to that used in the wet end of the Fourdrinier machine, are immersed in a vat of pulp. As the cylinders revolve, a film

of pulp is picked up on the outer wire surface. At the top end of the cylinder the pulp film is transferred to a wood felt and carried forward to the press and drying rolls. Several cylinders may be used in series, each adding a layer of paper to the sheet. This type of machine is used extensively in the manufacture of heavy papers and boards.

Although pulp and paper mills are not as serious fire risks, perhaps, as many other types of plants, there are certain special hazards present. In the chemical pulping processes, for instance, chips of wood are often carried in frame drag conveyors to the top of the digester house. Unless the chipper is kept clean and tight there is considerable danger of fire from friction. A fire starting at the chipper or in the conveyor has a flue to the top of the mill, where accessibility is



WHERE PULP BECOMES PAPER

difficult. Sound stock fire insurance protects the financial investment in the mills against these and all other fire dangers, standing as a bulwark between the owners and possible ruination of their business by a serious fire. As in most industries, insurance renders a service that has a stabilizing effect upon the business. Again, stocks of finished paper, stored at the

plants, represent a large value which is protected by insurance.

The paper industry has relied many times upon the advice and assistance afforded by fire prevention engineers representing stock fire insurance. Many fire dangers, naturally surrounding an industry handling an inflammable product, have been minimized by the adoption of safety precautions suggested to owners of mills and warehouses in all sections of the country. It has always been the policy of stock fire insurance to serve an industry by suggesting ways and means of reducing fire losses, thereby giving that industry the benefit of experience which has been helpful to others in preventing fire. Continued production and prosperity depend, in an industry like paper, upon uninterrupted manufacture. It is important that fire interruptions be minimized at all times, but particularly during the season when maximum production must be maintained.

From a small beginning the paper industry has experienced a tremendous growth. The total output in the United States did not exceed 3,000 tons in 1810, when the first records were computed. In 1850 it had increased to over 75,000 tons, in the next thirty years it reached 450,000 tons, and by 1900 the total production in the United States exceeded two million tons. Another ten years saw the output doubled. By 1920 it exceeded seven million tons, and in 1928 the total production amounted to ten million tons. A continued upward trend is likely but at a declining rate of increase. At the present time paper for social uses—that is, for printing and writing —requires about 40 per cent of the total output of the country. The remaining 60 per cent is composed of paper boards, wrapping paper, paper felts, and a variety of paper novelties.

Minutes of the First Meeting of the National Association for Research in Science Teaching

February 27, 1928

Following discussions which have been held on various occasions and at the suggestion of several people, W. L. Eikenberry of East Stroudsburg Teachers College (Pennsylvania) sent a circular letter to individuals believed to be interested in the promotion and dissemination of research relating to science teaching, asking them to meet in Boston at the time of the Conference of the Department of Superintendence of the National Educational Association. Upon the invitation of N. H. Black of Harvard University, those who responded to the circular letter met as guests of the Harvard School of Education at the Colonial Club in Cambridge, Monday evening, February 27th, 1928. Fifteen people attended the meeting.

The meeting was called to order by W. L. Eikenberry. The first order of business was the election of a chairman for the evening. Mr. Eikenberry was unanimously elected.

The following motions were proposed and passed:

(1) That S. R. Powers act as Secretary.

(2) That the Chairman and the Secretary together with other designated persons constitute the executive committee for furthering the Organization.

(3) That Elliott R. Downing be elected as third member.

(4) That a fourth member be elected to the committee to represent supervisors in the public school system. Harry A. Carpenter was nominated and elected.

(5) That the membership in the Association be of those interested in the supervision of science and in teacher training work for science teachers and all such others as may be elected to membership by the Association and that the Association meet at the time and place of the Department of Superintendence, National Educational Association.

(6) That those present and those invited should constitute the charter members.

(7) That an assessment of \$1.50 be laid upon those present, the funds to be used to promote the work of the Committee.

(8) That a continuation meeting be held at 12:30 on Wednesday, February 29th.

(9) That a vote of thanks be extended to the Harvard School of Education for use of their rooms and for the dinner which they served, and to Professor N. Henry Black for making the local arrangements.

The continuation meeting was called to order at 12:20, February 29th, 1928. Eleven people were in attendance. The following were proposed as motions and passed unanimously:

(1) The purpose of the Association is to promote scientific study of problems of science teaching and to disseminate the results of such study.
(2) The Committee shall investigate names of possible members and be prepared to recommend for additional membership at the next meeting.
(3) The Committee shall attempt to locate the schools in which research is being conducted and report at the next meeting problems which are under investigation.
(4) The Committee shall assemble the titles of unpublished theses.
(5) The Committee shall assemble the list of the problems which seem to need immediate study.
(6) Some one shall be nominated as curator and he shall be assigned responsibility for assembling studies and directing work of abstracting and digesting.
(7) Francis D. Curtis was elected as curator and as fifth member of the Executive Committee.
(8) The question of charter membership was again raised, and at this meeting the motion was passed that only those present at one or the other of the sessions of the Boston meeting shall constitute the charter members. (This action rescinded motion number 6 of the previous meeting.)
(9) The question of dues was again raised and it was voted that dues of $2.00 be laid and that the Secretary act as Treasurer. (This action rescinded motion number 7 of previous meeting.)
(10) The following was proposed and accepted tentatively as the name of the Association:— National Association for Research in Science Teaching.

The following were proposed as topics around which the next program might be arranged.

(a) Sequence in Science Teaching
(b) Laboratory Methods in Science Teaching

A list of names was proposed for membership and each person named was given indorsement by one or more of those in attendance.

MEMBERS OF THE ASSOCIATION ON FEBRUARY 25, 1929
(Starred names are charter members)

*C. E. Baer
State Department of Education
Albany, New York

*N. H. Black
Jefferson Laboratory
Harvard University
Cambridge, Mass.

Wilbur Beauchamp
School of Education
University of Chicago
Chicago, Ill.

Herbert Brownell
University of Nebraska
Lincoln, Nebraska

Otis W. Caldwell
Teachers College
New York City

*Harry A. Carpenter
Dept. of Public Instruction
Rochester, New York

*Gerald S. Craig
Horace Mann School
New York City

H. A. Cunningham
State Normal School
Kent, Ohio

*Francis D. Curtis
University High School
Ann Arbor, Mich.

*E. R. Downing
School of Education
University of Chicago
Chicago, Ill.

*W. L. Eikenberry
State Teachers College
East Stroudsburg, Pa.

C. W. Finley
State Teachers College
Montclair, New Jersey

J. O. Frank
State Teachers College
Oshkosh, Wisconsin

*Earl R. Glenn
State Teachers College
Montclair, New Jersey

A. W. Hurd
University of Minnesota
College of Education
Minneapolis, Minn.

*John Hollinger
Dept. of Public Instruction
Pittsburgh, Pa.

T. C. Jean
State Teachers College
Greeley, Colorado

*Homer W. LeSourd
Milton Academy
Milton, Mass.

Joseph R. Lunt
Boston Teachers College
Boston, Mass.

*Morris Meister
New York Training School for Teachers
135th Street and Convent Ave.
New York City

Ellsworth O. O'burn
John Burroughs School
St. Louis, Mo.

E. Laurence Palmer
Cornell University
Ithaca, N. Y.

*Ellis Persing
Cleveland School of Education
Cleveland, Ohio

*Charles J. Pieper
New York University
Washington Square
New York City

*S. R. Powers
Teachers College, Columbia University
New York City

*F. A. Riedel
Kansas State Teachers College
Pittsburg, Kansas

W. F. Roecker
Boys' Technical High School
Milwaukee, Wisconsin

C. L. Theile
Supervisor of Science
Board of Education
Detroit, Mich.

Morris Van Cleve
Supervisor, Nature Study
Board of Education
Toledo, Ohio

Ralph Watkins
University of Missouri
Columbia, Missouri

H. A. Webb
George Peabody College for Teachers
Nashville, Tenn.

*W. G. Whitman
State Normal School
Salem, Mass.

E. E. Wildman
Office of the City Superintendent of Schools
Philadelphia, Pa.

S. R. POWERS,
Secretary and Treasurer.

Minutes of the Second Meeting of the National Association for Research in Science Teaching

The first programmed meeting of the Association was called to order by President W. L. Eikenberry on February 25th, 1929, at 2:00 P. M., at the Cleveland Hotel. The program was presented as printed and in addition, Mr. Jesse Whitsit reported briefly on the report of Dr. John Tildsley, Assistant Superintendent of Public Schools, New York City. Dr. Tildsley's report is entitled, "Teaching Science as a Way of Life." The reports reflected the spirit of the Organization in that each of them was a report of significant research relating to problems of science teaching.

There were sixty in attendance, representing a wide geographical area.

The meeting closed about 5:00 P. M.

The program follows:

NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING
PROGRAM

Cleveland Meeting, February 25th, 1929
Cleveland, Ohio

Open Meeting, 2:00 P. M.
Hotel Cleveland, Room T

Presiding: W. L. Eikenberry, State Teachers College, East Stroudsburg, Pennsylvania

1. The Determination of Important Principles of Science to be Included in the Curriculum
   Elliot R. Downing, University of Chicago, Chicago
2. Inventory of Certain Aspects of Learning in Physics
   Earl R. Glenn, New Jersey State Teachers College, Montclair, New Jersey
3. Science Equipment in Missouri High Schools
   Ralph K. Watkins, University of Missouri, Columbia
4. The Achievement of Students in High School and University Physics
   A. W. Hurd, University of Minnesota
5. A Synthesis and Evaluation of Subject Matter Material in General Science
   Francis D. Curtis, University of Michigan, Ann Arbor
6. A Study of the Activities of Science Teachers
   Harry A. Cunningham, Kent State Normal College, Kent, Ohio
7. Present Specific Objectives in Junior High School Science as Revealed by Selected Investigations, Courses of Study and Textbooks
   Ellis C. Persing, Cleveland School of Education, Cleveland

Mimeograph sheets reporting research in progress by members of the Association or under their direction were distributed at the meeting. The names of those reporting together with titles is as follows:

H. A. Carpenter, Rochester, N. Y.

I. Determination and organization of a twelve-year course in science having dependent continuity. It involves:
   1. Science for Kindergarten and grades 1 to 3
   2. Science for grades 4 to 6
   3. Articulation of the elementary grades science with that of the junior high school
   4. Determination of organization and content for 10th year science, articulate with the junior high school science and introductory to the 11th and 12th year physics and chemistry
   5. Reorganization of physics on a basis of principles and integrated with 10th year science.
   6. Reorganization of chemistry on a basis of principles and integrated with physics.

II. Determination of the relation of final grades in physics and chemistry for pupils having had general science or biology preparation.

J. O. Frank, Oshkosh, Wisconsin

Superstitions of the Fox River Valley of Wisconsin, The Part They Play in Everyday Life, and What Science Education Should Do About It.

Morris Meister, New York Training School for Teachers, New York City, reporting for the Committee on Science of New York City of which he is chairman.

1. Aims in Science Teaching
2. Science Sequences in New York City
3. What Constitutes a Good Science Teacher

A Joint Committee on Research has just been organized, consisting of six members:

1. The President of the Physics Club
2. The President of the Chemistry Teachers' Club
3. The President of the Biology Teachers' Association.
4. The Chairman of the Committee on Science in New York City
5. The Chairman of the Secondary Science Section of the Experimental Society
6. The Chairman of the Elementary Science Section of the Experimental Society.

E. L. Palmer, Cornell University, Ithaca, New York.

1. An analysis of the problems and methods of value in the teaching of science to students in normal schools and teachers colleges.—E. L. Palmer and Karl Hazeltine.
2. An investigation into the factors influencing the response of a community in regard to the use of the recreational opportunities of its environment.—E. L. Palmer and Robert Johnson.

F. A. Riedel, Kansas State Teachers College, Pittsburg, Kansas

A Comparison of Several Factors in the Demonstration and Laboratory Methods.

Ralph K. Watkins, University of Missouri, Columbia, Missouri

1. Revision of Peters-Watkins unit tests in high school physics.
2. Actual practice in Missouri high schools in separation of illustrative demonstrations done by the teacher and those done by pupils in the laboratory for high school physics (with C. O. Williams).

3. A listing of experiments and exercises suggested in general science text-books.
4. Construction of unit tests for first year College Chemistry (with E. C. Buckner).

H. A. Webb, George Peabody College for Teachers, Nashville, Tenn.

1. Are High School Chemistry Texts Adequate in the Field of Organic Chemistry (Completed).
2. Are High School Chemistry Texts Adequate in the Field of Industrial Chemistry (Practically completed).
3. The Mathematics of College Chemistry (In progress).

S. R. Powers, Teachers College, Columbia University.

1. Professional content for teachers of Elementary Science.
2. Subject matter of Elementary Biological Courses in College.
3. Learning outcomes from laboratory notebook work.
4. Instruction in Chemistry in Agricultural Colleges.
5. Learning Elements essential to the development of ability of writing chemical equations.
6. Subject matter Objectives of High School Chemistry.
7. Building Health Concepts through the teaching of High School Biology.

E. R. Glenn, State Teachers College, Montclair, New Jersey

1. An Investigation of the needs of science teachers in small high schools.

J. A. Hollinger, Pittsburgh, Pa.

1. Tests for Natural Science in Junior High School—Grades 7, 8, and 9.

The business meeting was held at the dinner hour on February 25th, at the Cleveland Museum of Art. The members of the Association were the guests of the Cleveland School of Education. President W. L. Eikenberry presided. The items of business were as follows:

1. Qualifications for membership:
   It was voted that the Executive Committee formulate qualifications for membership. An essential qualification for membership is that the proposed member has published acceptable research.
2. Report of the Committee on Publications:
   The report of the Committee consisting of Messrs. C. J. Pieper, E. R. Glenn, and W. G. Whitman was as follows:

TENTATIVE REPORT OF COMMITTEE ON PUBLICATIONS OF NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

(Cleveland meeting—Feb. 25, 1929)

Your Committee presents the following report for your considerations and approval:

The Committee has canvassed various possibilities relating to publications of the Association. The major considerations which came before our committee are as follows:

1. Our Association has expressed an interest in publishing a Yearbook and members of the Association have suggested the publication of materials in a journal.

2. There is, at the present time, an urgent need for the publication of articles and studies, especially those of a research character, which will assist in integrating the science curriculum from the kindergarten to the junior college and thus place the teaching of science in a more favorable light. This need arises from or is shown by:
   - (a) The wide chasm between practice and the present knowledge of educational and natural sciences.
   - (b) The availability of a large amount of unpublished and valuable material of a research character.
   - (c) The growing quantity of results of productive research.
   - (d) The inadequacy and ineffectiveness of present journals in the field of Science Education.
   - (e) The activities of those interested in other subjects.
3. Whatever decision our Association reaches regarding its plan of publication it should
   - (a) attempt to publish materials of such nature as will cover the entire field of science teaching from the kindergarten to the junior college, including the normal schools and other teacher training institutions

     or

   - (b) coordinate its efforts in publication with one or more of the existing journals to the end that the product of such coordination will cover the entire field and present a unified program of science teaching.
4. Whether the Association publish separately or in coordination with existing journals, the scope of the publications shall be such that it will:
   - (a) present current investigations in science teaching.
   - (b) present abstracts or resumes of investigations completed in the past but not yet published.
   - (c) suggest problems for investigation.
   - (d) present excellent articles in science content, such as modern research in this or that science field or modern applications of science.
   - (e) furnish notices and reviews of books, courses of study, special pamphlets and bulletins on science teachin", and other publications of value to the science teacher.
   - (f) present personal notes and significant movements in our field.
   - (g) provide abstracts of articles in other journals, both educational and scientific.
5. Our Association may publish a Yearbook or monograph annually or at such intervals as the Association deems advisable, such Yearbooks or monographs to present comprehensive studies and to serve as a guide of the current trends in Science Education coordination with an existing journal, or it may arrange to publish its materials in one of the existing journals.
   - (a) Several specific possibilities are:
     - (1) Publishing articles in The General Science Quarterly.
     - (2) Publishing articles in School Science and Mathematics.
     - (3) Publishing articles in The Nature and Science Education Review.
     - (4) Taking over General Science Quarterly and effecting a new Journal of Science Education.
     - (5) Launching a new journal.
   - (b) Whatever plan is adopted the Association should have some plan of editorship and management.

7. The Association must consider plans of financing and promoting any plan of publication. The estimated costs of publications considered are here given:
   (a) A Yearbook or monograph of 160 pages, 6 by 9, bound in paper cover will cost approximately
   for 500 copies—$600.00 plus office expenses $200 equals $800
   for 1000 copies—$700.00 plus office expenses $200 equals $900
   If sold for $1.50 each, such yearbook or monograph will pay for itself, provided about 1000 copies are printed and sold. Any number above 1000 will yield a profit. School Science and Mathematics offers to publish 1000 copies of the Yearbook at approximately $1500.00.
   (b) Articles or studies, approximating a total of 30 pages per issue, will be published by General Science Quarterly at no expense to the Association.
   (c) Articles or studies, 30 pages or more per issue, will be published by School Science and Mathematics at the rate of $8.00 per page. The materials may be run in a separate section of consecutive pages under a department entitled Research in Science Education. The editor of School Science and Mathematics reserves the power to make final decisions on the inclusion of any materials. At the rate of 30 pages per issue for eight issues, this plan would cost the Association approximately $2000.00 annually. Four issues of 68 pages would cost $2096.00.
   (d) Figures for Nature and Science Education are not available. All that may be said now is that this journal will publish articles and studies at a minimum printing cost, all overhead expenses to be borne by the Nature Association.
   (e) 1. If the Association takes over General Science Quarterly and expands it to four issues of 68 pages each, the total expense will be approximately $1600.00 for the first year. Basic figures for this estimate are here given:

Expense

Cost of 4 issues of 1500 copies		$1600.00
Business and mailing		300.00
Promotion work		300.00
		$2200.00
Price of General Science Quarterly		2000.00
	Total	$4200.00

Income

12 pages advertisement	$1200.00	
Subscriptions (1000)	1400.00	
Total		$2600.00
Net Expenses		$1600.00

   The cost of the purchase of General Science Quarterly may be met by deferred payments over a period of 4 or 5 years.
   (e) 2. If the Association takes over General Science Quarterly and publishes 2000 copies, the expenses will be about $4600.00 and the income about $4000.00.
   (f) If the Association launches a new journal the total expense of 1000 copies of four issues of 68 pages each will be about $2200.00. The income will depend upon the number of subscribers and the advertising receipts. This income cannot be estimated since the subscription list would have first to be developed.

RECOMMENDATIONS

In the light of the considerations presented, your committee offers the following recommendations for your approval:

1. That the National Association for Research in Science Teaching launch upon a program of publishing materials of value to Science Education.
2. That the Association publish a Yearbook, annually or at such intervals as appropriate materials are available. Each issue of the yearbook shall be devoted to significant developments or current trends in Science Education or to a major aspect of this field.
3. That the Association publish at intervals throughout each year such professional materials as do not lend themselves to the purposes of the Yearbook.
   (a) The purpose of these materials shall be to promote an integrated program of Science Education.
   (b) The scope of these materials shall be the content and method of the teaching of science from the kindergarten to the junior college as well as the problems of training science teachers and supervisors.
   (c) The content of these materials shall include:
      (1) current investigations in science teaching.
      (2) abstracts and resumes of unpublished investigations completed in the past.
      (3) suggested problems for investigation.
      (4) modern research in pure and applied science.
      (5) reviews of current publications in the field of science and science teaching.
      (6) personal notes.
      (7) articles of a general nature significant to science teaching.
      (8) abstracts of articles in other journals, both educational and scientific.
4. That the Association take over the property interests and good will of the General Science Quarterly as a first step in the development of a new journal under an appropriate title such as The Journal of Science Education.
5. That the Association shall effect a corporation or organization for the purpose of financing and directing the development of the new journal.
6. That the Association shall select an editorial board to act in an advisory capacity on all matters pertaining to the editorial policies of publicaions, this board to be composed of members who represent the various interests which will contribute to an integrated program of Science Education.
7. That the Association shall create an executive board and authorize it to proceed, under the sponsorship of the Association and the advice of the editorial board with the following program:
   (a) A yearbook such as mentioned in Recommendation No. 2.
   (b) A journal such as mentioned in Recommendation Nos. 3 and 4.
8. That the Association determine on a subscription price of its journal and on a fair proportion of each subscription to be turned into the treasury of the Association beginning at such time as shall be most beneficial to all concerned in this program of publication.
9. That members of the Association take an active interest in the journal, secure subscriptions as rapidly as possible, and suggest or send to the editorial board available articles for publications as well as the names of possible advertisers.

Following the report it was moved to accept the offer of Mr. W. G. Whitman, Editor of "General Science Quarterly" to allow the use of his journal for one year as the official publication of the Association and that an option be taken for the purchase of the journal at the end of the year. After considerable discussion this motion was carried by a vote of 15 to 6. It was then moved to recommend to Mr. Whitman that the name of the Journal be "Journal of Science Education." It was moved that the Committee on Publications be continued and that it act as a representative of the Association on the Editorial Board of the journal during the year. A letter to the Secretary from Mr. Pieper under date of March 21, 1929 quotes from Mr. Whitman as follows:

> "I shall be very glad to have the Research Science Association use about thirty pages in each issue of the Quarterly for next year. I cannot promise that it will always be just thirty pages, and I shall wish the opportunity of making it less or more as circumstances determine. I am also willing to give the Association an option of purchasing the Quarterly a year hence on approximately the same terms as offered this year. I wish to be allowed the privilege of making some change should I so desire when the time comes. Also will change the name to Journal of Science Education."

A vote of thanks was extended to the School of Education for the use of their rooms and for the dinner which they served to the Association.

The Treasurer reported that thirty-one members had paid dues during the first year and that there was $62.00 in the treasury.

It was voted that the Executive Committee be continued another year.

Following the business meeting there was a discussion of the topic, Problems of Supervision in Science in City and State Systems. Leaders in the discussion were:

Harry A. Carpenter, City Schools, Rochester, New York
Edward E. Wildman, City Schools, Philadelphia, Pa.
Gerald S. Craig, Horace Mann School, Teachers College, New York City

S. R. POWERS,
Secretary and Treasurer.

The New Books

Test and Study Exercises in General Science—1928—J. T. Giles—Laidlaw Brothers, Chicago.

This is a work book in paper covers and has detachable sheets. There are 64 exercises and tests which cover 32 subjects. The exercises comprise 20 groups of statements concerning fundamental factors. There are four statements in each group. It is a type of multiple choice test in which the student is to pick out all the false statements. A test covering the same subject matter follows each exercise. These tests comprise 20 true-and-false statements. A teacher's handbook with correct answers has been prepared.

English and Science—1929—Philip B. McDonald—192 pages—$2.00—D. Van Nostrand Company.

"The most important officials in modern civilization usually write only two kinds of composition—letters and reports." This book gives first consideration to the principles of simplicity and conciseness. It presents an analysis of English for the engineer and engineering student. Some topics are: formal and informal reports; good letters and bad: obscurity, pomposity, and ornateness; conciseness, the cardinal secret of style; cultural reading for the technical student; an example of reading in the history of science; suggested readings about invention.

Beginning Chemistry—1929—Fletcher, Smith and Harrow—476 pages—300 illustrations—$1.60—American Book Company.

The first few chapters of this book aim to give the pupil a gradual transition from his earlier general science to the more difficult special science. The election theory with its application to chemical action is more complete than in any other elementary text we have yet seen. College entrance requirements are covered. There is good balance between theoretical and practical chemistry. A good list of review questions follow each chapter.

If Parents Only Knew — 1929 — Elizabeth Cleveland — 152 pages — $1.75—W. W. Norton and Company, New York City.

This book, sponsored by "Children, the Parent's Magazine," is a message from teachers to parents. It discusses the seven cardinal principles of education and attempts to show how the school and the home can and must work together. It tells what the school is trying to do for the child and suggests how the home can help.

Our Wonderful Universe—C. A. Chant—191 pages—136 illustrations—$1.52—World Book Co.

Our Wonderful Universe is an easy and stimulating introduction to the study of the heavens for students at about the junior high school level or older. The author approaches the subject from the observational side and endeavors to have the students actually see the solar system and other celestial bodies. We believe that it is one of the clearest and most satisfying popular elementary books on astronomy. Part I treats the celestial sphere and its motion; Part II, the sun and its system; Part III, the universe of stars.

The Human Mechanism—1929—Hough, Sedgwick and Waddell—691 pages—165 illustrations—$3.00—Ginn and Co.

For many years the Hough and Sedgwick *Human Mechanism* was the standard text on physiology. This second revised edition by Professor Waddell is a completely rewritten book. The space devoted to anatomy has been reduced and that to hygiene, sanitation and preventive medicine increased. The work is also issued in two separate books—"Elements of Physiology" and "Hygiene and Sanitation."

Theoretical Mechanics — 1929 — Joseph S. Ames and Francis D. Murnaghan—462 pages—Ginn and Co.

This new book was written for college and graduate students in physics and mathematics and for advanced students in engineering. *Theoretical Mechanics* is a comprehensive and readable account of the dynamical theories which are the basis of recent advances in physics, such as quantum, mechanics, wave theory, etc. The systematic treatment of vector analysis contributes to an understanding of tensor analysis and the relativity theory. Careful treatment is given to the postulates of Newton's mechanics, as well as to gyroscopic theory and wave motion.

Science Articles in Current Periodicals

ALUMINUM
- Aluminum on Trial. Sci. Am., 140:246, Mar. 1929.

ANATOMY
- Simple Lessons in Human Anatomy. Hygeia, 7:487, May 1929.

ANTARCTIC EXPLORATIONS
- Fliers Open the World's Ice Box. Pop. Sci. Mo., 114:4:24, Apr. 1929.
- Wilkins Returns from Antarctica. Sci. Am., 140:262, Mar. 1929.

ASTRONOMY
- Eclipse to Check Einstein. Pop. Sci. Mo., 114:5:21, May 1929.
- Sun of the Universe. Pop. Mech., 51:578, Apr. 1929.
- Solar Research for Amateurs. I. Sci. Am., 140:302, Apr. 1929 and 140:436, May 1929.
- Largest Amateur Telescope. Sci. Am., 140:442, May 1929.
- The World's Largest Telescope. Sci. and Inv., 16:920, Feb. 1929.
- Jupiter's Moon in the Making. Sci. and Inv., 16:918, Feb. 1929.
- Does Our Universe Rotate. Sci. Am., 140:216, Mar. 1929.

ATOMS
- Shattering the Atom. Sci. and Inv., 16:913, Feb. 1929.

AUTOMOBILE
- An Automobile Plant Without Men. Lit. Dig., 101:1:20, Apr. 6, 1929.

AVIATION
- The Real Fathers of Flight. Pop. Sci. Monthly, 114:4:42, Apr. and 114:5:48, May 1929.
- Studying Parachute Jumps. Sci. Am., 140:260, Mar. 1929.
- Radio Beacons. Sci. Am., 140:238, Mar. 1929.
- Builders of the Aviation Industry. Sci. Am., 140:228, Mar. 1929.
- Aboard the Sky Diner. Pop. Mech., 51:893, June 1929.
- Oakland Municipal Airport. American City, 40:5:142, May 1929.

BRIDGES
- Giant Bridge Joins Two States. Sci. and Inv., 16:914, Feb. 1928.

CALENDAR
- The Thirteenth-Month Calendar. Com. Am., 25:11:27, May 1929.

CHEMISTRY
- Gasoline from Coal: New Uses for Wood and Coal. Sci. Am., 140:322, Apr. 1929.

COPPER
- The Story of Copper. Jo. Chem. Ed., 6:413, Mar. 1929.

EAGLE
- The Eagle in Action. Nat. Geog. Mag., 55:635, May 1929.

EINSTEIN
- Einstein's Latest Theory. Pop. Mech., 51:536, Apr. 1929.

FERTILIZER
Nitrogen and the Fertilizer Industry. Jo. of the Frank Ins., 207:665, May 1929.

FLOWER GARDEN
Seed Sowing Chart. Amer. Home, 1.542, Mar. 1929.
A Little Garden That Looks Big. Am. Home, 1:537, Mar. 1929.
An Early Indoor Start With Seeds. Am. Home, 1:535, Mar. 1929.
Fitting a Garden to the House. Am. Home, 1:521, Mar. 1929.

FOOD
Unusual Vegetables. Hygeia, 7:465, May 1929.

FOUNDATION THINGS
What Things Are Made Of. Sci. Am., 140: , Feb. and 140:234, Mar. 1929.

GARDENS
Succession of Bloom in a Shaded Garden. Am. Home, 2:199, May 1929.
The Seasons in a Southern Garden. Am. Home, 2:200, May 1929.
The Late Spring Garden Activities. Am. Home, 2:202, May 1929.
The Latest Magic for Your Garden—Paper Mulch. Pop. Mech., 51:868, May 1929.
Farming Under Paper. Com. Am., 25:10:22, Apr. 1929.
Follow Up the Vegetable Garden. Am. Home, 2:346, June 1929.

HEALTH
Our Developing Knowledge of Immunity. Hygeia, 7:269, Mar. 1929.
Putting on a Health Week. Hygeia, 7:260, Mar. 1929.
Marriage and Health. Hygeia, 7:250, Mar. 1929.
Blood Transfusion: The Business of Selling Blood. Hygeia, 7: 470, May 1929.
How to Control Diseases in School. Hygeia, 7:362, Apr. 1929.
Your City and Your Health. Hygeia, 7:373, Apr. 1929.
Atmospheric Pollution. Am. City, 40:5:135, May 1929.

HYGIENE
The Filthy Swimming Pool Must Go. Am. City, 40:111, Apr. 1929.

INSECTS
Why Do Insects Migrate. Sci. Am., 140:328, Apr. 1929.

LIGHT
Light as an Aid to Surgery. Trans. Ill. Eng. Soc. 24:371, Apr. 1929.
Transmission of Visible Radiations. Trans. Ill. Eng. Soc., 24: 384, April 1929.

LIGHTING
Decorative Lighting for Out-of-Doors. Trans. Ill. Eng. Soc., 24: 325, March 1929.

LIGHTNING
Putting Lightning to Work. Pop. Sci. Mo., 114:5:17, May 1929.

METALS
Beryllium—The Wonder Metal, Pop. Mech., 51:603, April 1929.
New Tool Metal: Carboloy, Sci. Am., 140:241, March 1929.

METEOR
What a Meteor Did to Siberia. Lit. Dig., 100:11:33, May 1929.
Rocks That Fall from the Sky. Pop. Mech., 50:570, April 1929.
A Meteor That Said "Shhh!" Lit. Dig., 101:2:24, April 13, 1929.

MOVIES
How Movies Are Made to Talk. Radio, 11:5:11, May 1929.

PHOTOELECTRIC CELLS
Experiments with "Light-Sensitive Cells." Radio News, 10:909, April 1929.

PHOTOGRAPHY

Photography an Avocation and Inspiration. Photo Era, 62:257, May 1929.

Practical Photographic Hints. Photo Era, 62:257, May 1929.

PHYSICS

The New Outlook in Physics. Sci. Am., 140:393, May 1929.

PLANTS

Have Plants a Heart Beat. Sci. Am., 140:414, May 1929.

RADIO

Radio Tubes and Their Characteristics. Radio News, 10:822, April 1929.

Cabinet Resonance in Dynamic Speakers. Radio, 11:3:13, March 1929.

The Electrostatic Loud Speaker. Radio, 11:3:13, March 1929.

Radio Picture Transmission and Reception. Radio, 11:3:17, March 1929.

How to Make Your Radio a Phonograph. Radio News, 10:914, April 1929.

List of Broadcasting Stations (Corrected to April 13, 1929). Radio News, 10:1122, June 1929.

Remote Control by Radio. Radio, 11:4:13, April 1929.

Radio Picture Transmission and Reception. Radio, 11:4:17, April 1929.

Hitching Phonograph to Radio. Pop. Sci. Mo., 114:5:62, May 1929.

The Man Who Made Radio Talk. Pop. Sci. Mo., 114:5:32, May 1929.

SPAIN

Seville, More Spanish than Spain. Nat. Geo. Mag., 55:273, March 1929.

On the By-paths of Spain. Nat. Geo. Mag., 55:311, March 1929.

SCIENCE TEACHING

"Shall the Laboratory Work in the Public Schools be Curtailed." —A Criticism. Sch. Sci. and Math., 39:411, April 1929.

Foster Science Clubs in the High School. Jo. Chem. Ed., 6:496. March 1929.

Research in Science Teaching. T. C. Record, 30:344, Jan. 1929.

ULTRA-VIOLET LIGHT

Ultra-Violet Transmitting Glass. Sci. Am., 140:338, April 1929.

VIRGINIA

Virginia — A Commonwealth That Has Come Back. Nat. Geo. Mag., 55:403, April 1929.

VISUAL EDUCATION

Principles on Use of Visual Methods in Higher Education. Ed. Screen, 8:100, April 1929.

Practical Application of the Descriptive Caption in Visual Education. Ed. Screen, 8:102, April 1929.

The Excursion Project. Ed. Screen, 8:104, April 1929.

An Adventure with Visual Aids. Ed. Screen, 8:115, April 1929.

The Educational Museum. Ed. Screen, 8:39, Feb. 1929.